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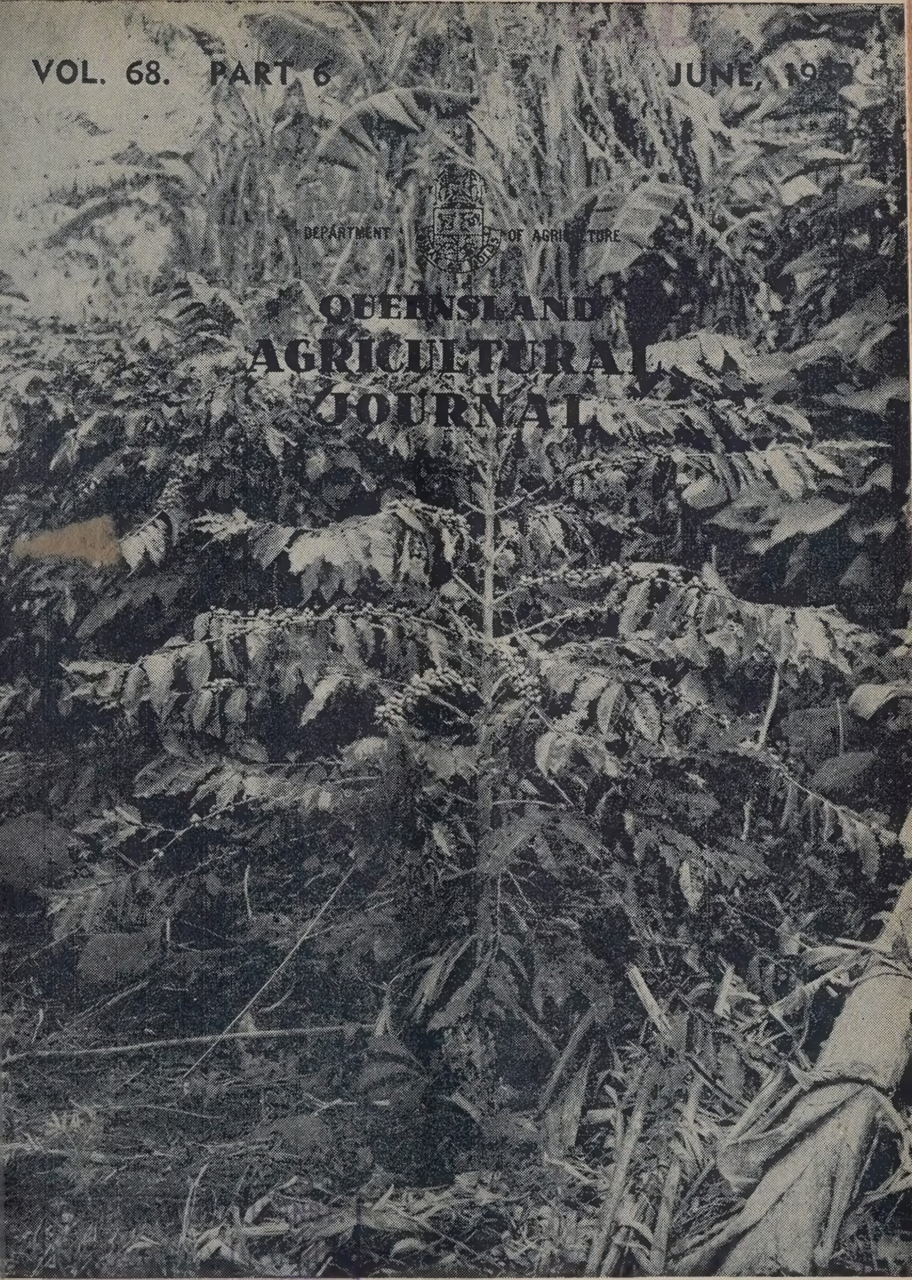
DEPARTMENT OF AGRICULTURE

QUEENSLAND AGRICULTURAL JOURNAL



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11

Contents

The Handling and Storage of Maize on the Atherton Tableland.

W. R. STRAUGHAN, Senior Adviser in Agriculture.

MAIZE growing on the Atherton Tableland commenced over 60 years ago. In the beginning, following the falling and burning of the rain forest, seed was hoed in amongst the stumps. Later the hoe gave way to the single furrow "swing" plough, but the stumps remained for many years in the paddocks before being finally removed.

The industry received a big impetus with the introduction of closer settlement following the first World War; the area sown to maize rose rapidly and has for nearly a quarter of a century approximated 25,000 acres, or 11-12 per cent. of the State's total.

The area cropped is intensely concentrated and is almost entirely encompassed within three-mile radii of the townships of Atherton, Tolga and Kairi, which themselves are within six miles of one another (see Plate 156). The three nests of storage silos are situated in these centres. The maize area is in fact the most concentrated area under maize in the Commonwealth of Australia and lends itself admirably to a system of unified control, such as is at present employed through the Atherton Tableland Maize Marketing Board.

It is the purpose of this article to briefly describe this system, but before doing so it would be an advantage to make some reference to weather conditions and their influence on cropping routine and particularly to the variance of the latter from southern practices.

GROWING CONDITIONS.

The average annual rainfall in the maize areas of the Tableland is 52 inches. Distribution follows the general seasonal pattern for the remainder of the State in that three-quarters of the total is registered during four summer months, December to March. It differs in that falls are usually of lower intensity and of longer duration, providing persistently damp conditions somewhat peculiar to the district and

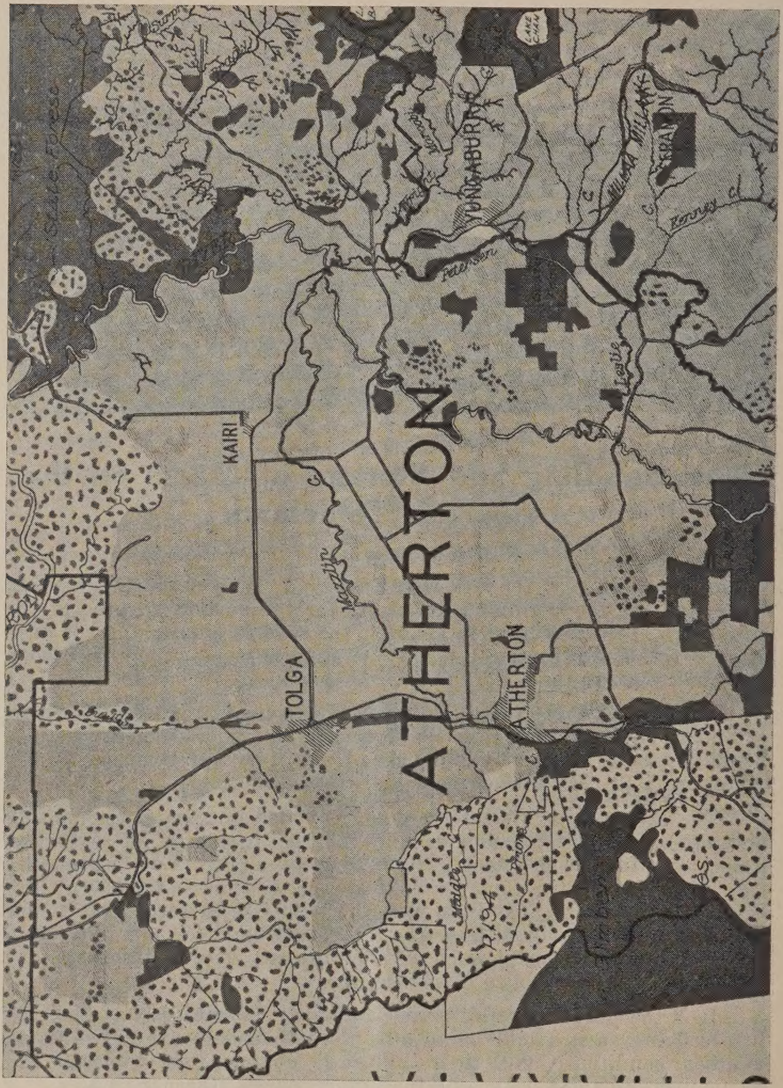


Plate 156.

Photograph of Portion of the Bureau of Investigation's Land Utilisation Map of the Atherton Tableland.—The plain light area represents cultivated land used primarily for the production of maize and dairy forage crops; the hached area is land devoted to dairy pastures, the spotted area is open forest or scattered timber, and the dark areas State forests, timber reserves or National Parks.

which, although promoting rapid plant growth, present difficulties for the storage of grain without the aid of artificial drying and weather-proof storage facilities.

The crop, as elsewhere, is sown in drills about 4 feet apart, but the rate of seeding is much lower and the stand seldom reaches 33 plants per row chain. Plants grow rapidly and usually reach up to 12 feet in height. Owing to continued wet weather in most seasons, interrow cultivation is frequently hampered. Prolific weed growth, which usually develops after cultivation ceases and as the maize crop nears maturity, does not appear to have any material effect upon yield, although it may cause inconvenience at harvesting, particularly when machines are employed.

The varieties grown are peculiar to the locality and have been developed within the area from introduced strains. Cobs are large, with a heavy husk covering. The grain is large, inclined to be softer and starchier, lighter in colour and, as a result of wet climatic conditions, of higher moisture content at harvest time than southern grown maize.

Yields are relatively high, the average for the district over the past 25 years being 32 bushels of sound grain per acre. Yields of 80 or more bushels per acre have been reported for individual farms.

As elsewhere, the crop is subject to diseases of the cob, mainly Diplodia ear rot. These cob rots can become very severe in seasons favourable to disease; for example, if wet and showery weather is experienced during the cob's development, normally in March and April.

No economic control of cob rots in the field has been developed and as a consequence diseased ears have to be rejected from the harvest, since their inclusion would not only materially reduce the appearance and sale value of the product but would also cause trouble in storage. Cob rots are one of the major factors adversely affecting yield.

THE ATHERTON TABLELAND MAIZE MARKETING BOARD.

The difficulties experienced in handling maize as a result of local weather conditions and the marketing problems arising from distance from large markets, together with the unique concentration of the industry, induced farmers to seek a solution to their many problems in co-operation.

In 1923, therefore, growers, taking advantage of the facilities offered under the *Primary Producers' Organisation and Marketing Acts*, formed a Maize Pool and undertook the erection of storage silos and the installation of artificial drying conveniences for the handling and marketing of their commodity. The first crop to be handled by this organisation and with these facilities was that for the season 1924-25, when 17,099 tons of maize were handled and marketed on behalf of Tableland growers.

Over the past quarter of a century, covering 24 completed crops, deliveries to the Pool have totalled 389,703 tons, or an annual average of 16,238 tons.

Although production in the district has fluctuated from season to season, deliveries have remained at a consistently high level, there being only three occasions on which less than 11,000 tons was received by the Board.

During this period, the Board has developed a system of bulk handling which has been attended with a large measure of success. Success is gauged by the price paid to growers for maize; this, after all shelling, handling, bagging, administrative and incidental costs have been deducted, has averaged £8 1s. 8d. per ton for the past quarter of a century. This price, if coupled with the value of the Board's accumulated assets of buildings and machinery over the period, would therefore represent the equivalent of a payment of nearly 5s. per bushel for maize shelled, bagged and delivered at railway sidings by maize growers in other parts of the State.

HARVESTING.

Manual Picking.

Harvesting usually commences in May or early June and continues for several months, terminating some time in October, just prior to the planting of the succeeding crop.

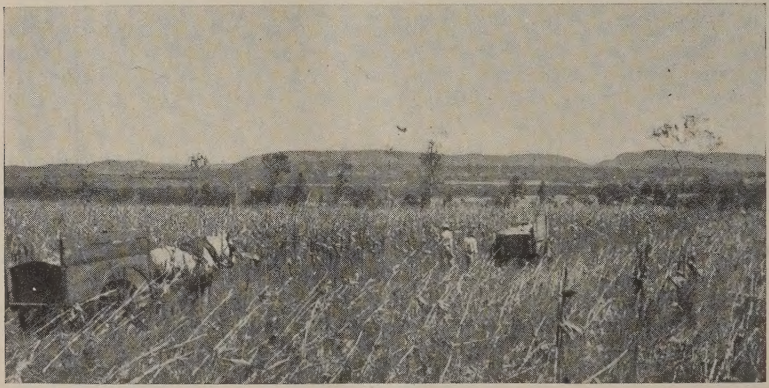


Plate 157.

HAND PICKING OF MAIZE.—The cobs are pulled by hand, dehusked, and thrown into the carts.

Until recently, harvesting has been almost entirely by hand. Cobs are husked on the stalk, snapped off and then cast into light carts, which are "boarded up" on one side and along the front (Plate 157) as an aid to the manual picker, whose tossed cob usually strikes the "board" and falls back into the vehicle. At this time diseased cobs are rejected; they are generally deposited in bags fastened to the cart or into a small sectioned-off portion in the cart itself, since, although unsuitable for delivery to the Board, they have a use in the home feeding of farm animals. Carts are emptied into the farmer's barn, where the harvest awaits delivery to the Maize Board.

In earlier years, pickers were highly skilled in this work and, at a contract rate of 18s. to 25s. per ton, found a remunerative living in maize harvesting. Lately, however, lack of skill and the rising cost of living have forced picking rates up to over £2 per ton and this, coupled with the extreme shortage of available labour, has greatly influenced the introduction of mechanical harvesting.

Mechanical Harvesting.

Maize harvesters or " picker-husker " machines are designed to pick or snap the cob from the plant, remove the husk and deliver the husked cob into an attached trailer. They are quite distinct in design and operation from the standard small grain header-harvesters which have also been successfully employed to some extent in maize harvesting in other parts of the State.

Excluding the " picker-sheller," which picks and shells the grain, these machines may be grouped into four distinct types:—

1. *Mounted or Push Types.*—These are completely mounted on and supported by the tractor.

Plate 158.

MECHANICAL HARVESTING OF MAIZE.—Rear view of a two-row pull type picker at work on the Atherton Tableland.

2. *Semi-mounted Type.*—In this type the machine is partly supported on the rear of the tractor and partly on its own chassis and ground wheel or wheels. Normally the manufacturers regard this type as a pull type.

3. *Pull Type.*—The machine is completely carried on its own chassis and wheels and is drawn behind the tractor (Plates 158 and 159).

4. *Auto-type.*—This type has the power unit as an integral part of the machine.

Except for the auto-types, which are two-row machines, pickers may be of either one or two-row construction. All types and all makes, however, work on the same principle, major variations existing only in the husking arrangements.

Plate 159.

MECHANICAL HARVESTING OF MAIZE.—A two-row pull type picker completing a round. The maize at this stage is too dry for good husking. Note the broken stalks and the heavy weed growth.

[*Photo. G. Blom, Cairns.*

Briefly, two guides, one on either side, pass along the maize row. Gathering chains, situated within the inner edges of the guides, gather the maize stalks towards the snapping rolls.

The snapping rolls, two in number, are fitted between the guides. Special interlocking lugs encircle the rolls, which revolve towards each other on their upper edges, thus drawing the maize stalks through in a downward direction, snapping off the cobs, which, being thicker than the stalk, are unable to pass between the rolls.

Adjustments to meet varying thicknesses of stalk, size of cob, and wet and dry weather conditions, are provided for in the variable space between the rolls.

From the snapping rolls, cobs are passed, generally by an endless belt conveyor, to the husking machinery. Husking is accomplished on a set or sets of rollers, 2½ to 3 inches in diameter, arranged in pairs and revolving, as in the case of the snapping rolls, towards one another at their upper edges and fitted with various forms of surface irregularities calculated to grip and tear the husk from the cob. In an alternative system the husking rolls are simply an extension of the snapping rolls and the cobs pass direct and in a straight line from the snapping rolls to the single pair of husking rolls.

Contact of the cobs with the rollers is maintained by an arrangement pressing the cobs against the rollers. This may be an endless belt

of slats revolving above the cobs, or alternatively several "paddles" actuated on an eccentric. Each system is cushioned on springs and is adjustable to the desired pressure.

Because of the necessity, under Tableland conditions, to hand select and reject Diplodia-infested cobs, clean husking is essential, so this section of the mechanism is of vital interest to the Tableland grower.

Machines with alternate rubber and steel rollers have so far shown a distinct superiority over the all-metal types and under favourable conditions have removed the husk covering from 90 per cent. of the cobs harvested. Rubbers, however, soon become smooth and worn and lose efficiency; consequently, it is necessary to renew or recover the rubber rolls after every 200 to 250 hours of work.

Most efficient husking is obtained before the plant is completely dry—that is, when the grain still contains 18-20 per cent. moisture. Late in the season, the husk becomes brittle and cannot be effectively torn from the cob. At this stage, the stalk is also brittle and breaks up under the action of the snapping rolls, resulting frequently in the loss of the cob.

With one man to operate the tractor and picker in the field and a second to remove and empty the trailers, a single row machine will harvest from 8 to 9 acres a day and a double row machine from 14 to 15

Plate 160.

SHELLING MAIZE IN THE FIELD.—The trailer is taken direct from the picker to the sheller and the shelled grain is loaded direct into open trucks for immediate delivery to the silos.

[*Photo. G. Blom, Cairns.*

acres. A single row picker can be successfully operated by a 16-horse-power tractor, but two-row machines require additional power. Cobs, as in the case of hand harvesting, are temporarily stored in barns awaiting cartage to the silos.

So far accurate costs for machine harvesting have not been determined. However, it has been established that the operating costs of a maize harvesting unit, consisting of a mechanical picker, a tractor to power the picker, a tractor to haul trailers to and from the barn, two trailers and a team of two men, are less than 12s. 6d. per acre for harvesting and storing maize on a farm. It is believed that, when capital costs are added to this figure, machines will still compete successfully with even highly-skilled manual picking. Although it does not appear that mechanical pickers can ever completely replace hand labour, it seems certain that they will remain a permanent feature of economic maize production on the Tableland.

SHELLING.

Except in a few isolated instances, all maize is shelled by the Board. The Board's machines are capable of shelling 20 tons of husked maize per hour and are worked as either stationary or mobile units, operating either at the silos or moving from farm to farm, whichever is the more economical or convenient.

Plate 161.

DELIVERY OF MAIZE TO THE SILOS.—The motor trucks are ready to empty their loads of cobs into the scales at the Atherton silos.

[*Photo. G. Blom, Cairns.*

Costs are variable. Shelling at silos is estimated to cost only 1s. 3d. per ton, but the cost of movement greatly increases the cost of field or barn shelling. Normally field shellers (Plate 160) are used only during the peak of the harvest when the intake at the silos has to be maintained at its maximum.

CARTAGE.

Both cobs and shelled grain are carted from barns to silos in bulk (Plate 161). Cobs are loaded into motor lorries by powered elevators. Grain is loaded direct from the sheller. Lorries are boarded up to a height of approximately 5 feet above the floor of the vehicle and each lorry carries between 4 and 5 tons of cobs or grain per load.

Delivery to the silos is controlled and directed according to a pre-arranged itinerary for all lorries and so provides a continuous supply of grain to the silos without congestion as well as maintaining an equitable acceptance of grain from various growers as harvesting proceeds.

Attention is given to the condition of the maize in farmers' storage and care is exercised to obviate any loss by overheating, weevil infestation or other cause of damage.

Cartage rates are set by the Board and revised each season. Advances commensurate with rising costs are made from time to time but, as a result of organisation which minimises loss of time due to congestion at the silos and other causes, rates remain comparatively low.

Maize is also received in railway ballast trucks or hoppers, and conveniences at the silos conduct this grain through the same channels as when delivered by motor lorry.

RECEIVING AND HANDLING.

On delivery to the Board, loads, if in cob, are tipped into an underground conveyor which feeds the sheller; the shelled grain is then led to a sunken bucket type weighbridge for weighing, while the core or shelled cob passes along a conveyor to a receptacle for use as fuel in the steam boiler. Where field or farm shelled grain is being delivered, loads are tipped direct into the weighbridge through a grid at ground level provided for that purpose. While the maize is in the scales, samples are drawn off from each load by a standard spear type of sampler and set aside for moisture content and grading determinations.

All maize is accepted on a 14 per cent. moisture basis and any excess is deductible from a supplier's gross weight. Deductions are also made for dead grain and offal as indicated by the sample and penalties are imposed for any amount of dead grain exceeding 3 per cent. of the bulk load.

The weighed and sampled grain passes from the scales by underground conveyor and elevator to the separator or cleaning machine, which extracts dust, broken grains, other foreign matter, and as much as possible of the dead grain. Where it is necessary to do so—that is, when the grain has more than 14 per cent. moisture—excess moisture is extracted by a battery of dryers.

MAIZE DRYERS.

Briefly these dryers may be described as vertical cylinders 16 feet high and 8 feet in diameter with a steam jacket around the circumference and enclosing numerous vertical tubes, perforated at the base, through which the maize passes and around which steam is allowed to

circulate. A pressure fan delivers air at the base of the dryer and this, entering through the perforations at the base of the tubes, is forced through the falling grain and expelled at the top of the dryer.

When the dryers are in operation, maize is elevated to the top of the cylinder, where it is distributed to the numerous tubes and falls towards the base, the rate of fall being controlled by a shutter at the base of the dryers. Steam is injected to heat the falling columns of grain, and moisture thus liberated is carried off by the upward blast of air from the fans.

Adjustments to the rate of drying may be obtained firstly by the steam admitted into the jacket, which can be accurately controlled by the pressure valve; secondly by the fan blast, which is controlled by the air shutter on the fan; and thirdly by the rate of flow of the

Plate 162.
THE MAIZE SILOS AT ATHERTON.
[*Photo. G. Blom, Cairns.*

maize itself, which is controlled by the exit shutter. Normally steam pressures are kept low to avoid overheating and damaging the maize, fan blast is kept high, and the rate of drying is regulated by the grain flow. All maize is reduced to a uniform 14 per cent. moisture content for storage.

The rate of drying, measured in terms of weight of maize treated per unit of time, varies according to the moisture percentage of the maize being dried and to the relative humidity of the atmosphere at the time. Thus, maize containing 20 per cent. moisture can be reduced to the 14 per cent. standard at the rate of 10 to 12 tons per hour. Maize at 18 per cent. moisture is reduced at the rate of 12 to 14 tons per hour;

Plate 163.

THE MAIZE SILOS AT KAIRI.

[*Photo. G. Blom, Cairns.*

but at 16 per cent. moisture, because the water is increasingly less freely liberated as the moisture content nears 14 per cent., the rate for maize dried increases to only 14 or 16 tons per hour.

Maize at over 20 per cent. moisture is too immature and consequently unsatisfactory for drying. It has to be passed over the dryers twice to avoid scalding and damage and when dried retains the acid flavour and aroma associated with immaturity. In drying, too, the grain starch shrinks away from the outer skin and hull and the grain rapidly becomes pale in colour and stores poorly.

After leaving the dryers, grain is cooled in the "cooler," a large gauze enclosure, where the heated grain is exposed to a draft of cool air. On cooling it is elevated to the top of the silos, recleaned, and directed along a special endless belt to the particular bin desired.

SILO STORAGE.

The silos or bins (Plates 162 and 163) are cylindrical concrete structures 25 feet in diameter and 70 feet high. Each can hold 700 tons of well-packed dry maize, but some inconvenience is experienced in filling to this limit and practical working capacity is regarded as being between 600 and 650 tons.

Grain in the silos is drawn off when required at the base, whence it can, by a system of electrically driven conveyor belts and elevators, be directed to any point in the set-up—that is, into another silo, after being recleaned and if necessary cooled, to the automatic bagging-off scales, or to the mealing machines.

The main problems of bulk maize storage occur in the silos themselves. Maize at 14 per cent. moisture will generally store without fermenting or heating, but any accumulation of moisture resulting from uneven drying, humid or wet weather, a leak in the silo roof or walls, weevil infestation, or even a patch of maize containing a high percentage of diseased grain, will cause a rapid rise in temperature. If the position were not relieved mould could spoil the entire bin of 600 odd tons of grain.

Diseased and dead grains are the major sources of temperature rises in the silo and the introduction of this class of grain is avoided as far as possible. Particular precautions against introducing occasional loads of badly diseased maize into bins of sound maize are always taken, since these sources of "hot spots" require the turning of the whole silo of maize to correct the trouble occurring in the relatively small amount of bad corn.

The obvious objection is, of course, an economic one. A further important reason is that the turning mixes the bad grain still further through the sound grain. Again, dead grain breaks up gradually, and although much of it is eventually extracted by the separator even continued turning does not completely dispose of it.

All bins are fitted with tubes passing through the full depth of the silo, and by lowering a thermometer to various depths within these tubes the temperature throughout the bin's entire depth can be ascertained. Temperatures are read weekly at 7 feet depth intervals. At

the first sign of a sudden rise over 30 degrees C.,* the maize is turned—that is, it is emptied from the affected silo, recleaned, recooled and passed to another silo. Given favourable conditions of cool dry weather at the time, this operation can reduce the moisture content of "warm" maize by up to $\frac{1}{2}$ per cent., and this is usually sufficient to obviate a recurrence of the trouble.

Well matured grain, field dried to 14 per cent. moisture or less and filled into silos on a cool dry day or night, will store at as low a temperature as 18 or 19 degrees C. These favourable conditions, however, seldom occur for a full bin. A very satisfactory temperature is 22 degrees C. and maize will store for long periods without much change at even 26 degrees C.

Damage to grain is occasioned when the temperature reaches 35 degrees C., and consequently when the rise in temperature exceeds 30 degrees C. turning has to commence.

At every filling of a silo and on every occasion on which maize is turned, moisture tests are taken at regular 20-minute intervals during the operation—that is, approximately for every 40 tons of maize.

A complete record of moisture tests and temperature readings is logged; from such records the history of all maize is known and subsequent temperature rises and danger points are accurately anticipated and speedily corrected. These records also constitute a most reliable guide to maize quality.

Temperature fluctuations are emphasised in the comparison of readings for silos when first filled from farmers' mixed deliveries and those in which the maize has been turned once. In the first instance, temperature readings are very irregular and unstable, whereas in the second instance temperatures are more even through the full depth of grain and remain constant for long periods.

The following extracts from the Board's log of temperatures illustrate the general pattern of the procedure of receiving and recooling maize for storage and also indicate the temperature changes which may take place in the process.

Extracts for four consecutive weeks for the 1947-48 crop toward the close of the receiving season are presented. The charts are for the Atherton nest of ten silos and for three interspaces, numbered 5, 8, and 11 in the tables, which are also used but which have a capacity of only 160 tons each.

Weevil infestation is controlled by carbon bisulphide. The fumigant is placed in trays set in the manholes in the top of the silos.

The rate of application of carbon bisulphide (2 gallons per bin) is below the recommended standard. During the early days of the silos larger quantities were used, but because of the objectionable nature of the fumigant and the difficulty of removing the odour from the maize

* Readings in degrees Centigrade can be converted into degrees Fahrenheit by multiplying by 9/5 and adding 32. For example, 30 degrees C. = $\frac{30 \times 9}{5} + 32 = 86$ degrees F.

TEMPERATURE CHART (IN DEGREES C.) FOR AUGUST 20, 1948.

Depth in Feet from Top of Silo.	Silo or Interspace Number.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
7	..	..	..	..	..	22	22	..	22	..	..	..	..
14	..	..	24	..	..	24	22	..	21	..	18	18	..
21	..	..	28	..	..	26	22	..	20	..	19	18	..
28	..	..	24	..	..	27	23	..	24	..	19	18	..
35	25	..	27	30	..	24	22	..	21	..	18	20	..
42	32	26	29	29	..	25	21	..	20	..	18	20	..
49	31	26	29	28	..	24	22	..	24	20	18	22	19
56	30	29	24	23	..	25	22	..	23	21	20	23	19
63	24	26	22	24	..	24	23	..	22	21	20	23	18

Silos 1 to 4 contained maize direct from the grower and silos 6 to 13 (with the exception of interspace 8, which was empty) contained grain which had been turned and recooled. Attention is drawn to the low readings in interspace 11 and silo 12, which were filled during cool weather. Maize in silo 2 which heated suddenly on top was being turned to silo 13, but silo 1 rose suddenly and had to be turned in its stead. Silo 6 was marked for bagging-off because of the comparatively high readings at the 21-feet and 28-feet levels.

TEMPERATURE CHART (IN DEGREES C.) FOR AUGUST 27, 1948.

Depth in Feet from Top of Silo.	Silo or Interspace Number.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
7	..	..	..	..	..	..	22	19	22	..	..	18	21
14	..	..	23	..	..	..	21	19	21	..	18	18	22
21	..	..	28	..	..	35	22	19	20	..	18	18	20
28	..	19	27	31	..	29	22	20	25	17	18	18	19
35	..	23	27	30	..	25	23	20	22	17	18	20	18
42	..	22	29	30	..	25	21	20	23	18	18	23	19
49	..	23	29	28	..	24	22	20	25	18	21	22	18
56	..	25	23	22	..	26	22	20	24	18	22	24	18
63	23	19	22	23	..	26	22	20	23	18	21	23	18

The principal changes from the previous week were that silo 2 had been emptied into silo 13 and was being refilled with incoming maize. Silo 1 has turned partly to silos 13 and 10 and the interspace 8, while silo 4 has commenced turning into silo 10. A quantity of maize was bagged off from silo 6, but a sudden rise at the 21-feet and 28-feet levels necessitated a temporary delay in bagging-off in order to cool and turn the "hot spot" into the interspace 5.

TEMPERATURE CHART (IN DEGREES C.) FOR SEPTEMBER 3, 1948.

Depth in Feet from Top of Silo.	Silo or Interspace Number.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
7	25	..	..	..	18	..	21	20	23	20	..	18	21
14	20	..	..	..	19	..	21	19	21	21	18	18	23
21	20	..	..	..	19	..	22	20	21	20	18	19	21
28	20	..	..	..	18	..	22	19	28	18	19	19	20
35	21	25	..	..	18	..	22	20	22	18	18	21	18
42	19	24	19	..	19	..	22	20	27	18	18	22	18
49	21	26	17	..	19	24	22	20	25	18	21	22	19
56	22	26	19	30	21	26	22	20	24	18	23	23	19
63	22	27	21	26	21	27	22	20	23	18	22	22	18

By 3rd September silo 4 was nearly empty, but the process had to be stopped when silo 3 became hot and was emptied into silo 1. Silo 3 then commenced refilling from 2 and 4. The "hot spot" of silo 6 had been turned into interspace 5 and bagging off continued in silo 6. By this time deliveries from farmers had declined.

TEMPERATURE CHART (IN DEGREES C.) FOR SEPTEMBER 10, 1948.

Depth in Feet from Top of Silo.	Silo or Interspace Number.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
7	26	..	21	..	..	..	22	21	..	20	..	18	23
14	20	..	23	..	..	..	22	20	..	21	18	18	24
21	20	..	22	..	..	18	22	20	..	21	19	21	23
28	21	25	19	..	..	18	23	20	..	19	19	22	21
35	22	24	19	..	..	21	24	20	..	18	19	23	19
42	20	22	22	..	..	20	23	20	..	19	19	23	19
49	21	22	18	..	..	22	23	21	..	18	23	23	20
56	23	22	19	..	25	21	23	20	..	18	25	24	19
63	22	18	22	..	25	21	23	20	..	19	23	23	18

By 10th September silo 2 had been emptied into 3 and silo 4 had been turned into 2. Silo 6 had been completely bagged and silo 9 turned into it. Interspace 5 had been bagged off for sale and partly refilled from deliveries, which had almost ceased by this time. All maize, with the exception of that in interspace 5, had been re-cooled for storage.

grain when the larger dosages were used, the amount of fumigant was gradually reduced by trial to the present dosage. It is claimed that at this strength insect infestation is kept at a low enough level for commercial purposes. After fumigation the maize is turned to remove any objectionable aroma from the grain and also because it is usual to find that a silo requiring fumigation to check insect infestation at the same time requires turning to correct a temperature rise.

Trials are in progress to determine whether benzene hexachloride preparations can be used to replace carbon bisulphide partly or wholly in silo fumigation.

MAIZE DISPOSAL.

As sales are contracted maize is bagged-off from the silos. Grain passes, after cleaning, direct to the automatic weighing machine. Bags are filled to a standard net weight of 149⅓ lb. (15 bags per ton), thus allowing rapid sewing. Under this system, six men—one operating the scale, three sewing and two loading—are capable of bagging-off and stacking into railway trucks 25 tons per hour or 5,000 bags per day. The greater bulk of the maize is disposed of by rail, and loading direct into railway trucks is assisted by chutes leading from the bagging platform. Road vehicles loading on the other side of the silos, and which cater for local trading only, are fed by hand trollies.

Maize is offered for sale as whole grain, as cracked (kibbled) grain, as meal, or incorporated in mixed stock foods.

CURRENT PROBLEMS OF BULK MAIZE STORAGE.

To accommodate the present rapid change from hand to machine picking which is taking place, new problems have presented themselves to the Maize Marketing Board.

The primary danger with mechanical picking lies in any inefficiency of the machine in removing the husk well enough to allow of a quick and efficient inspection of each individual cob, in which case dead grain

could and does find its way past the shellers to the silos. If not removed, this inferior grain will reduce the general quality of stocks and provide all the problems attendant upon the storage of dead grain.

To obviate this problem, a new separator has been designed and inserted into the line of grain travel on the top of the silos. Dead grain has been found to give up moisture more readily than sound grain in the dryers and thus immediately following drying such grain can be and is more readily "lifted" from the separator riddles. The successful separation of dead from sound grain would obviate the need for manual inspection of his crop by the grower before delivery and would materially reduce his handling costs.

Owing to the risk of fire associated with the shelling at the silo of maize carrying a fairly high percentage of husk covering, such crops are best shelled in the field. Alternatively, some provision must be made at the silos to trap and destroy the husks immediately following shelling. The Board hopes to accomplish this by using a blast incinerator and is making preparation for the erection of such a safety measure.

Picking machines work most efficiently in "wet" crops and may deliver much grain of a high and probably uneven moisture content. This will complicate handling, since it will test the capacity of the Board to dry the maize and probably, by creating an unevenness in the moisture content of concurrent deliveries from various farms, intensifying the drying problem. To meet the situation, either the Board will need to instal additional dryers or farmers will have to build additional barn space of a type in which the cobs will not heat. Suitable storage is provided by slatted V-shaped cribs, which will allow of a complete circulation of air around the stack of cobs. This type of storage structure obviates fermentation of the grain and allows a gradual loss of moisture.

The unrestricted use of mechanical harvesters could overload silo intake, cartage facilities, and even farm barn capacity as the position stands at present. The remedy adopted is to arrange that all pickers work to an itinerary mutually agreed upon by representatives of the Board and machine operators so that the rate of shelling and cartage can be adjusted according to the various capacities and limitations of all facilities.

No problems that can be seen now are insurmountable, but the solution of all of them may take some time. The efficient procedure in the handling and storage of maize on the Atherton Tableland based on manual picking has been developed over a long period of trial and error, often in the face of many difficulties. To meet the new situation created by the rapid increase in mechanical harvesting, modifications and changes will certainly be necessary, but judging by the success of past performances there is no doubt that a satisfactory system of handling and storing maize in conjunction with mechanical harvesting will be achieved eventually by the Atherton Tableland Maize Marketing Board.

A Mechanical Arrowroot Harvester.

APART from its widespread use as a fodder crop in coastal districts, the arrowroot plant is grown for flour extraction on about 500 acres on the south coast.

Hand digging of the crop for flour purposes is laborious work, the estimated labour requirement being one man per ton per day.

A Brisbane inventor, Mr. G. H. Burke, has devised a machine of original design for the harvesting of arrowroot bulbs. This machine is illustrated in Plates 164-166. The essential parts of the harvester are as follows:—

(1) A heavy flattish and somewhat pointed share or blade which can be regulated for depth and which is adjusted so as to pass under the crowns of the plants.

(2) A small, slightly inclined conveyor which carries the material lifted by the blade into a cleaning drum.

(3) A cylindrical wire cleaning drum fitted internally with iron vanes and having a central spindle carrying agitators.

(4) An endless belt elevator delivering into a chute or slipper.

The harvester is driven by a tractor power take-off attachment fitted with a self-operating clutch.

The operation of the machine is quite simple. The digging elevator lifts the bulbs, which are conveyed to the revolving drum or rumbler, which cleans the stool and breaks it into individual bulbs. The loading elevator carries the bulbs upwards and empties them on to the slipper. which delivers into a truck travelling in the same direction as the machine.

With one man driving the tractor and another attending the harvester, an output of 5 tons per hour could probably be maintained.

In trial runs the harvester has delivered the bulbs into the motor truck in a satisfactory condition, only slight bruising occurring in comparison with the appreciable amount of crushing which results from hoe digging.

The use of a mechanical harvester of this type would necessitate greater speed in the processing of the bulbs and particularly in the drying of the flour. This aspect is now under consideration.

Patents covering the harvester and blade have been applied for by Mr. Burke.

Plate 164.

BURKE'S ARROWROOT HARVESTER.—General view, showing the digging elevator, the revolving drum, the loading elevator and the slipper in the travelling position.

Plate 165.

BURKE'S ARROWROOT HARVESTER.—View showing the loading elevator and the slipper in the travelling position.

Plate 166.
BURKE'S ARROWROOT HARVESTER.—Showing the slipper in position for loading.

WORLD FOOD SUPPLY IMPROVES.

The Food and Agriculture Organisation of the United Nations, in a report on the world food situation, states that world food production for the year ending 30th June, 1949, will be materially higher than in 1947-48.

Stating that agricultural crop production for direct human consumption is "about back to pre-war levels," the report points out, however, that total food available does not reach the pre-war figures because animal products are still considerably lower than they were before the war.

The increased crop production is attributed primarily to exceptionally favourable seasonal conditions in Europe and North America in 1948, in contrast to the unusually bad weather and low yields in Europe in 1947.

This increased crop production, F.A.O. states, means that aggregate supplies of both food and feed grains are substantially larger than last year's, but reduced livestock numbers (due in Europe to the feed shortage the previous year and in America to competitive alternatives and comparative price factors) have caused a decline in meat and other animal products supplies this year below the 1947-48 level. In the second half of 1949, however, a rapid increase in poultry and pig products is expected. Milk production, also, has already shown some response to better pastures and feed supplies, but because of the time required to build up dairy herds this progress must continue to be slow.

Overall, however, per capita world supplies of food in 1948-49 are only around 90 per cent. of pre-war supplies per capita. One important reason for this is the fact that world population has increased by about 10 per cent. since before the war.

PLANT PROTECTION

Tomato Diseases and their Control.

J. E. C. ABERDEEN, (formerly Pathologist, Science Branch).

THE tomato plant is subject to attack by a large number of diseases, many of which may cause substantial losses to growers if adequate precautions are not taken to deal with them. Preventive measures should be adopted as far as possible, because they are generally cheaper and more satisfactory than control measures applied to crops which are already infected. The programme of disease prevention and control should be planned well in advance of the planting of the crop, since it involves consideration of the following matters:—

(1) The purchase of disease-free seed.

(2) The planting of only those varieties which possess some degree of resistance to Fusarium wilt.

(3) The careful establishment of the seed-bed.

(4) The choice of the position of the field planting, only after consideration of a suitable rotation.

(5) Ensuring that adequate supplies of fungicides and insecticides are ready for immediate application.

(6) Ensuring that the spray apparatus is working efficiently.

KEY TO AID THE IDENTIFICATION OF TOMATO DISEASES IN SEED-BED AND FIELD.

The following key should help in the identification of the major tomato diseases, apart from nutritional disorders. Any determination of a disease made by using this key, however, must be checked by referring to the detailed descriptions of the symptoms given later under the heading of that disease. If the disease does not appear to correspond with any of those described, further advice should be obtained from the Department of Agriculture and Stock.

IN THE SEED-BED:

1. Seedling stem shrivels at ground level, and falls to the ground .... **Damping-off.**
2. Stem shows a dark-brown to black spot near soil level; growing tip often purplish in colour .... **Target Spot.**
3. Leaves show small, dark spots .... **Target Spot, Bacterial Spot,** or **Septoria Leaf Spot.**
4. Leaves and stem show relatively large dark, rotted areas .... **Irish Blight.**
5. Entire seedling stunted and purplish; no disease apparent on leaves, stem, or roots .... **Faulty Nutrition** or **Virus Disease.**
6. Seedling stunted; growing tip producing thickened distorted leaves; stem shows a characteristic bronze-green colour and reduced number of hairs .... **Tomato Mite.**

IN THE FIELD:

1. Entire plant wilted—

(a) Wilting very rapid—sometimes in a few hours—suggesting plant severed from root system; no yellow leaves. Stem at soil level may or may not show a light-brown discolouration of woody tissues .. **Bacterial Wilt.**

(b) Wilting very slow—sometimes takes weeks; older leaves show distinct yellow colour; affected leaves break off easily from stem. Stem and leafstalks show light-brown to dark-brown streaks under bark in hard, woody tissue .... **Fusarium Wilt** (in summer), or **Verticillium Wilt** (in winter).

(c) Some stems show splitting and rotting of internal tissue with mealy appearance; affected leaves do not break away from stem readily; leaflets on one side of leaf usually affected first (see also fruit symptoms) .... **Bacterial Canker.**

2. Entire plant stunted—

(a) Bronze markings on young leaves; these curved downwards more than normally .... **Spotted or Bronze Wilt.**

(b) Young leaves show light and green markings and tendency to crinkle .... **Mosaic.**

(c) Young shoots swollen and distorted, with last-formed flower buds standing erect; purplish colouration throughout tips .... **Big Bud.**

(d) Young leaves malformed, with leaflets very spindly and fernlike .... **Fern Leaf.**

(e) Irregular, greyish-black, slightly-sunken streaks on stem or leaves .... **Streak.**

(f) Young shoots show intense purplish colouration .... **Faulty Nutrition, Excessively Cold Temperature, Virus Disease, Irish Blight,** or **Target Spot** (attacking stem).

3. Leaves and stems—

(a) Small spots about ⅛ inch in diameter, with grey centres and small black pin-point dots. Leaves at base usually affected first .... **Septoria Leaf Spot.**

(b) Dark-brown spots, up to ½ inch in diameter—sometimes larger on stem—with sharp margins and often with concentric ringed appearance. Basal leaves usually affected first. By far the commonest leaf spot .... **Target Spot.**

(c) Large, dark-brown lesions often involving entire leaflet. These have the appearance of a wet rot in humid weather but are papery if atmosphere is dry. May show first on any part of plant .... **Irish Blight.**

(d) Lesions uniformly small, rarely greater than ⅛ inch in diameter, dark-brown in colour .... **Bacterial Canker or Bacterial Spot.**

(e) One leaf, or part thereof, shows decided wilt (see also fruit symptoms) .... **Bacterial Canker.**

(f) Older leaves yellow without any obvious spotting; with or without wilting of tips .... **Fusarium Wilt.**

(g) Large yellow indefinite lesions on upper surface of leaf, accompanied by a characteristic velvety dark layer of fungus under leaf. Only severe in wet northern regions of Queensland .... **Leaf Mould.**

4. Fruit—

(a) Dark, sunken spot present on flower end of fruit **Blossom-end Rot.**

(b) Mottled, brown markings covering large proportion of fruit surface; spread very rapidly (see also leaf and stem symptoms) .... **Irish Blight.**

(c) Very dark spots, sunken and velvety, commonly up to ¾ inch in diameter, usually originating from stalk attachment, growth-cracks or other injury .... **Target Spot** and other **Alternaria Rots.**

(d) Small spots 1/16 to ⅛ inch in diameter, usually with light halo around margin .... **Bacterial Canker.**

(e) Small spots 1/16 to ⅛ inch in diameter, often raised and scab-like; no halo .... **Bacterial Spot.**

(f) Large tough white spot on side facing sun .... **Sunburn.**

(g) Blotchy ripening .... **Mosaic,** or other **Virus Disease, Shade Spot,** or other **Physiological Disorder.**

(h) Fruits generally dwarfed, mis-shapen and hard .... **Virus.**

(i) Fruit completely broken down by watery rot .... **Bacterial** or **Fungous Rot** following insect or other injury.

(j) Fruit angular, with large air spaces inside .... **Puffiness**

(k) Blossom end of fruit mis-shapen .... **Catface.**

(l) Reduced fruit set with plant otherwise normal .... **Blossom Drop.**

Plate 167.

TARGET SPOT ON FOLIAGE.—Inset shows concentric rings more highly magnified.

TARGET SPOT.

This disease is very common both in the seed-beds and on the plants in the field. The seedlings do not always show obvious symptoms, as they may be attacked only on the stem at ground level and exhibit merely a hard, stunted appearance. A period of warm, moist weather following infection may soon cause the death of such infected plants. If the infection is unnoticed and the seedlings are planted out into the field, the stem lesion usually develops to a dry shrunken area, which may cause retardation of the growth of the transplants and result in a girdling of the stem leading to death of the affected plants, or leave the plants so weakened that they readily snap in the wind. This symptom is usually known as "collar rot." A plant may recover, if it has been transplanted sufficiently deeply, by developing new roots above the target spot lesion.

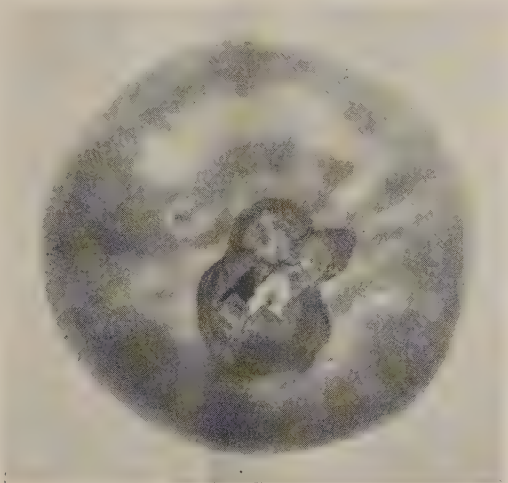


Plate 168.

Target Spot on Fruit.

Leaves, stems, and fruit may be affected on plants in the field, but the older leaves usually show the symptoms first. Dark brown spots, commonly $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter but up to $\frac{1}{2}$ inch under favourable conditions and with definite margins, are produced on leaves and stems. These spots may be marked by the concentric rings (Plate 167) from which the common name of the disease is derived. They may also have a yellow margin. The fruit lesions are in the form of black to dark-brown oval to round spots, which usually occur immediately on the edge of the stem scar (Plate 168) but may be also scattered about the fruit. In the former case, they may often be associated with a growth-crack, but at other times the disease appears to have attacked the fruit stalk first and subsequently entered the fruit. The fungus does not grow readily in green fruit, so that a mature green fruit which is infected, although not showing any spots when forwarded to the market, may develop the disease as it commences to colour.

This disease is caused by one particular fungus (*Alternaria solani*), but when causing fruit rots it may have associated with it several closely-related fungi which help to extend the damage. All of these fungi are far more resistant to dry weather conditions than is the fungus causing Irish blight, and they appear to require very little moisture and wind movement for their development and spread. Also, the target spot fungus prefers warm temperatures, so that in south-eastern Queensland the autumn and spring are the seasons most likely to provide conditions favourable to epidemics, though the disease may be present to some extent throughout the year. Observations indicate that the disease advances more rapidly when the plant is carrying its maximum load of fruit, and that if plants are backward in any way they are more readily attacked. The available evidence suggests that the target spot fungus is readily carried over in the soil from season to season.

Target spot is present throughout all the tomato-growing areas of Queensland, and probably causes a greater aggregate loss than any other tomato disease. The slower and less spectacular spread than in Irish blight results in greater neglect by the growers and treatment is often commenced too late to do any appreciable good.

Control.

Copper sprays and dusts are the most efficient fungicides available for the control of this disease. The usual spray strength for field use is that given by 4-2-40 Bordeaux mixture; commercial copper compounds should be used at the equivalent strength of copper. With a crop like tomatoes, where rapid growth necessitates frequent applications of the fungicide in order to maintain a covering on the growing tips, it is very likely that a weaker strength of Bordeaux would exercise economic control. In considering dusts, however, it is not recommended that anything less than a strength of 7 per cent. copper should be used, to be increased to 10 per cent. if conditions are favourable to the spread of the disease.

The degree of control obtained by the use of fungicides is not, however, always completely satisfactory. Hence, the destruction of the diseased crop by burning at the end of the season is more essential for the protection of the next crop than in the case of Irish blight, and the adoption of a three years' rotation is another worth-while precaution.

Furthermore, great care should be exercised in the selection of the seed-bed site, and the precautions given later regarding seed-bed management should be followed carefully. Also, the plants should not be held in the bed longer than necessary if early signs of the disease are present.

Bordeaux mixture or a copper spray shoud be reduced to a 2-1-40 strength when used in the seed-bed and not applied within two days of transplanting, as the loss in transplanting may be increased considerably if conditions are dry at the time. If collar rot is regularly causing trouble in the seed-beds, a solution at the same strength as for application to the plant may be watered directly on the surface of the soil after planting the seed.

IRISH BLIGHT.

The first evidence of the presence of this disease is usually in the form of extensive dark-brown to black lesions on the stems and leaves (Plate 169). In moist weather the leaf lesions have the appearance of a

wet rot and may even show a white downy growth on the lower surfaces of the leaves, but when dry conditions prevail the lesions are dry and papery. The fruit is readily attacked in all stages of development, a large mottled-brown lesion with indefinite margins usually covering at least one-fourth of the fruit surface being produced (Plate 170). A

Plate 169.
Irish Blight on Stem.

minor symptom of Irish blight is an intense purple discolouration of an individual stem, apparently due to interference with the food supply to that stem caused by girdling. Where no control is exercised, an apparently vigorously growing crop of tomatoes may be reduced to a mass of blackened leaves and stems within a few days, somewhat similar to the result of frosting.

Where conditions favour its development, Irish blight is the most destructive and spectacular of the tomato diseases. It is very closely related to the Irish blight of the potato, and under certain conditions the disease may readily pass from one crop to the other. In Queensland its importance varies from one district to another. It is uncommon in the Stanthorpe district, and when it does occur there, it is not until the end of the season, i.e., during April and May. In the Brisbane-Redland Bay area it may attack plants at any time from April to October, depending on the local weather conditions. The disease is less common

in the Yarwun-Rockhampton area, although it does occur there occasionally during the winter months. In the Bowen area it is of very rare occurrence. This variation in severity of incidence can be correlated with the temperatures and humidities of the growing season in each area.

Plate 170.
IRISH BLIGHT ON FRUIT.

Irish blight is caused by a fungus (*Phytophthora infestans*) which grows very readily in cool, moist weather. As indicated above, the disease appears only in the cooler months, during which time it may become epidemic only when favoured by continued showery conditions and overcast skies. Heavy dews also favour its spread. The extremely rapid development of the disease, which sometimes occurs, is usually brought about, however, by a succession of sharp, cold snaps, as the causal fungus, under these conditions, can reproduce itself even more rapidly than when the weather is uniformly cool and moist. If the temperature rises appreciably, or dry weather appears, the spread of the disease ceases immediately. As Queensland winters are normally dry, epidemics of Irish blight are not common in this State. The memory of one such epidemic is, however, sufficient to keep a grower conscious of the possibility of a recurrence for a number of years.

Control.

This disease can be controlled by the use of copper sprays or dusts. Owing to the rapidity with which the disease can spread, the usual practice is to commence application of a fungicide in the seed-bed without waiting for the disease to appear, and to continue treatment throughout that portion of the year in which climatic conditions favour-

able to the spread of disease may occur. Normally, the interval between applications is 7 to 10 days; this period may need to be shortened if climatic conditions are unusually favourable to the development of Irish blight, whereas during prolonged dry spells it may be increased. As for target spot, it is not advisable to reduce the strength of a dust below 7 per cent. copper. Sprays weaker than the standard 4-2-40 Bordeaux mixture could possibly be used, but thoroughness of application must never be neglected.

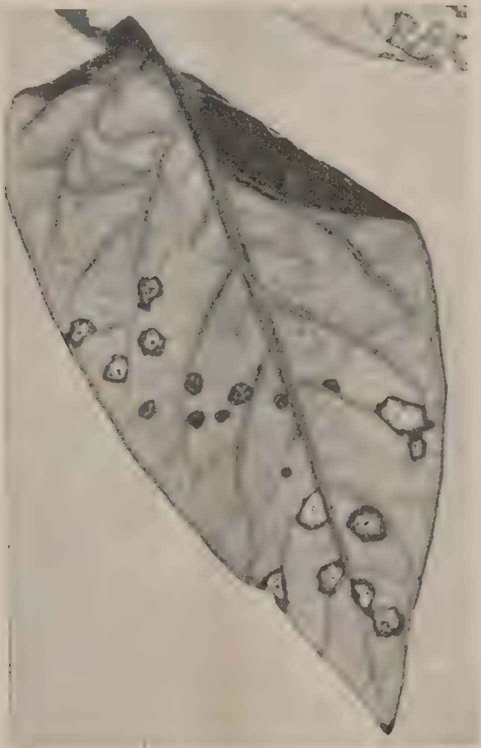


Plate 171.

SEPTORIA LEAF SPOT ON LEAF.

It must be noted that tomatoes may be packed in apparently good condition and develop the symptoms of Irish blight while in transit to, or on, the market. Hence, if the grower has Irish blight in his crop it is advisable for him to hold the fruit for three or four days before packing.

SEPTORIA LEAF SPOT.

The fungus (*Septoria lycopersici*) which causes this disease produces small brown spots about $\frac{1}{8}$ inch in diameter, scattered over the lower leaves of the plant. While the margins of the spots remain brown, the centre develops a light-grey colour and is characteristically studded

with a number of small black pin-points which are the tops of the minute, flask-shaped spore receptacles belonging to the fungus (Plate 171). The lesions are usually much smaller than those of target spot, but the early stages could readily be confused with bacterial spot. Yellowing of the leaf takes place around the spots and gradually spreads until the leaf dries out and withers. The lower leaves are killed from the bottom up, and a scalding of the fruit thus exposed to the sun may result.

Septoria leaf spot occurs in all of Queensland's tomato-growing areas, but is not nearly as important as Irish blight or target spot. This disease is most serious in the warmer months of the year.

Control.

The plants in the seed-bed and the field should be sprayed or dusted with copper mixtures as recommended for other leaf diseases, and all tomato refuse should be collected and burned as soon as the crop is off. This disease is seldom present unless in association with either Irish blight or target spot, so rarely requires special treatment. As Septoria leaf spot seriously affects plants which are not growing vigorously as a result of inadequate fertilizer application or insufficient cultivation, attention to these aspects of the tomato crop's requirements helps to lessen the incidence of the disease.

LEAF MOULD.

An important point in diagnosing this disease is that it is only likely to occur seriously in the very high rainfall districts of Queensland, that is, north and south of Innisfail. A characteristic symptom in this area is the premature death of the older leaves, leaving the plant with a ragged appearance somewhat similar to the result of defoliation by target spot. Another characteristic is the appearance on the lower surface of the leaf of a velvety dark growth, which is the causal fungus. In the earlier stages of the attack the leaves show indefinite yellow lesions on the top surface. Infection of the fruit is unusual, but the blossoms may be attacked and destroyed.

The disease is caused by a specific fungus (*Cladosporium fulvum*) and the essential factor for its spread is a very high humidity. While the disease has been recorded as far south as Brisbane, the only area that can fulfil the necessary conditions for a period long enough to encourage an epidemic is from Ingham to Cairns. Here leaf mould often surpasses target spot in importance. While the disease is present in most other countries, it is usually troublesome only in glasshouses.

Control.

Within glasshouses great stress is laid on the importance of controlling temperature and humidity. That is to say, temperature should be kept below 70 deg. Fahrenheit and relative humidity below 70 per cent., and ample ventilation should be provided. Control of these conditions in a field crop is usually out of the question. However, it will be seen that areas well protected from winds are the most likely to be affected, as high relative humidities develop more readily in still atmospheres. The breeding of tomatoes resistant to leaf mould has been successful in some areas, but owing to the different strains of fungus

no one variety is successful everywhere. For example, Vetomold, one of the most useful under American conditions, is a relative failure in Queensland.

Plate 172.
BACTERIAL SPOT ON FOLIAGE.

Salicylanilide sprays have had some success in New Zealand and English glasshouses and may be useful here. In Queensland, however, copper sprays at a strength equivalent to 4-2-40 Bordeaux mixture are the most widely used. While these are not particularly effective, general experience indicates that the measure of control justifies the expense.

BACTERIAL SPOT.

The bacterium (*Xanthomonas vesicatoria*) responsible for this disease attacks the leaves, stems and fruits. On the leaves (Plate 172) and stems (Plate 173) the disease appears as small brown spots similar to the early stages of Septoria leaf spot and target spot. They are differentiated from the former in that they do not develop the grey centres and pin-point fruiting bodies, and from the latter in that they remain comparatively small and do not develop concentric rings. Also,

if the bacterial spots are examined from the lower surface of the leaf, it will be found that many of them have a greasy surface. In addition to attacking leaves and stems, the disease forms small dark greasy spots on the flower hands which cause a considerable loss due to flower drop.

Plate 173.
BACTERIAL SPOT ON STEM.

On the fruit, bacterial spot appears as a small black raised scab-like spot (Plate 174) which may increase in size to approximately $\frac{1}{8}$ inch in diameter. When approaching the maximum size, however, the centres become slightly sunken. If the spotting is severe a number of spots will sometimes coalesce, forming a more extensive area. The size of the individual spot depends on the amount of growth that the fruit makes after it is infected, and does not increase after the fruit has matured. The fruit cannot be infected after a certain stage of maturity has been reached, which appears to correspond with the disappearance of the hairs from the fruit.

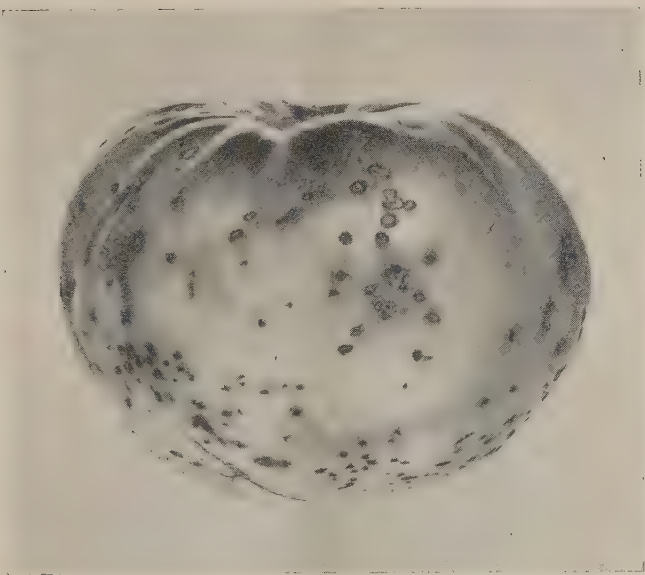


Plate 174.
Bacterial Spot on Fruit.

This disease differs from bacterial canker in that the fruit spot has no coloured halo and it causes no wilting of the plant. It may, however, cause extensive defoliation. The fruit spot does not penetrate past the tissue immediately under the skin and if extensive rotting occurs it is due to other organisms entering the bacterial spot injury. No new spots develop in storage or in transit.

Late summer and autumn appear to be the most favourable periods for development of this disease, probably because rain is the main factor in its spread. Wind-blown rain followed by drizzly overcast weather create ideal conditions, but normally they are of brief duration.

The disease is widespread throughout the older tomato-growing areas and has caused considerable losses within the last few years. The damage on the fruit is usually noticed first.

Control.

The man sources of infection with bacterial spot appear to lie in the seed and in the soil, and the subsequent spread by handling the plants does not seem to be of the same consequence as in the case of bacterial canker. Hence, the precautions to be observed in seed selection and treatment must be emphasized as being of primary importance. Seed contamination is usually confined to the outside of the seed, so routine treatment with corrosive sublimate, copper oxychloride, or one of the mercurial seed dressings is definitely recommended. The general precautions in selection and treatment of the seed-bed, as discussed later, are also strongly recommended.

There is evidence that the application of copper sprays sometimes checks bacterial spot, but, if conditions are favourable to the spread of the disease, their use is generally of little benefit. On the other hand, crop rotation is of definite value in dealing with this disease.

BACTERIAL CANKER.

As bacterial canker is very easily spread from plant to plant by handling, especially in pruning a trellised or staked crop, it is important to be able to recognize the early symptoms of the disease. In a young infected plant one leaf, or perhaps only the leaflets on one side of a leaf, droops and wilts, while the remainder of the plant looks quite normal and vigorous. Following this preliminary wilting, there appears a die-back of the growing tip (Plate 175), and this is accompanied by a splitting of the stem.

The wilting of the leaflets on one side of the leaf, mentioned for the young plant, is also characteristic of the disease in the older plant. If an affected leaf on such a plant is broken or cut off, a brown discoloration of the tissues can be observed on the exposed area of the stem. On peeling away the surface layer of the stem just over this discoloured portion, the tissues are seen to have a mealy appearance. This discoloration advances into the inner portion of the stems as the disease progresses. In the later stages of the disease the stems of an affected plant may split and produce the cankers from which its name is derived.

Plate 175.

BACTERIAL CANKER ON YOUNG PLANT.—Leaf on left shows wilting of leaflets on one side only.

The leaf spots are usually round and very small, and not particularly characteristic, but the fruit spots generally have a white margin with a split in the centre and are therefore more characteristic and are suggestive of another name sometimes given to this trouble—bird's-eye spot (Plate 176). The spots are rarely over $\frac{1}{8}$ inch in diameter, and are not raised as is often the case with bacterial spot.

Plate 176.
BACTERIAL CANKER ON FRUIT.

Several other tomato diseases display symptoms which are similar to those produced by bacterial canker; for example, the one-sided wilt of the early stages of bacterial canker occurs at times in bacterial wilt and may also be caused by a stem-boring caterpillar. In addition to bacterial wilt, bacterial canker may be confused with Fusarium wilt. However, there is usually some distinguishing characteristic by which the diseases may be separated; for example, the golden yellow discoloration of Fusarium wilt is not found in bacterial canker, and the lower leaves do not break off so easily as is the case when Fusarium wilt is the cause of the trouble. Again, the mealy discoloration of the internal tissues of the stem which occurs in bacterial canker extends right into the pith, whereas in the case of Fusarium wilt and bacterial wilt the discoloration is confined to the water-conducting tissue, which presents a woody appearance.

Bacterial canker, as the name implies, is caused by a species of bacterium (*Corynebacterium michiganense*). The disease develops most rapidly in the early autumn and spring months, but crops affected in the early autumn will readily carry the disease into the winter. The

rate at which bacterial canker may spread in an affected crop is accelerated by the onset of rain, but it is not so strikingly dependent on rain as is bacterial spot.

Although the disease originally enters the crop through the medium of infected seed, its subsequent spread takes place either by the handling of the plants in pruning or other operations or, after the stems crack, by the splashing of the plants with bacteria in raindrops. Bacteria are present in large numbers in the stem cracks, and, if splashed on to the leaves and fruit by rain, extensive spotting will develop.

The only important tomato-growing area in Queensland from which bacterial canker has not been recorded is the Bowen district. This does not mean that it is not present there, however, because it could remain undetected for a considerable time in crops growing unpruned on the ground. So long as care is exercised in seed selection and treatment, it is unlikely that canker will affect a whole district to the extent that Irish blight may in a season which is favourable to its development. However, it can be disastrous for the individual grower, especially if he is trellising or staking the crop and has made several prunings before discovering the presence of the disease.

Control.

One of the most essential points in dealing with this disease is to obtain, if it is at all possible to do so, seed from a disease-free source. A grower who saves his own seed should take special precautions against bacterial canker infection, one of the most important of which is to allow the seed and pulp to ferment for three to six days without adding any water. The formation of acids in the fermenting pulp kills any bacterial organisms which may be present in the seed and in the pulp. However, as the type of fermentation may vary with different conditions, it is recommended that the seed be dried after cleaning and then treated in a corrosive sublimate solution according to the directions given later. Seed from an unknown source should also receive this treatment. Seed treatments with acetic acid and hot water may also be used. In spite of the seed treatments, however, the main emphasis must always be on disease-free seed.

Before the pruning of a tomato crop is commenced an experienced person should check through the crop and mark all plants suspected of being infected with bacterial canker. If more than 5 per cent. of the plants are so affected it is advisable to leave the crop unpruned on the ground, thus reducing handling to a minimum. The hands should be washed very thoroughly in soap and water after working with any diseased plants, and any material which will be used again next season (such as stakes) should be sprayed with 2 per cent. formalin and immediately covered with bags for several hours. None of the usual sprays exercises any appreciable degree of control of this disease.

[TO BE CONTINUED.]

Hand-feeding Sheep in Drought Time.

G. R. MOULE, Officer in Charge, Sheep and Wool Branch.

(*Continued from page* 306 *of May issue.*)

Organising Drought Feeding.

A GOOD deal of organising is necessary to carry out drought feeding successfully. This will include arranging for regular market reports in order that the feed can be bought to the greatest advantage, arranging rail and road transport, and distributing the feed to the sheep so that each animal gets its proportionate share. The mechanics of the former points do not come within the scope of this article, but woolgrowers are reminded that they should always have one month's feed on hand. In addition, the station truck should be kept in good order.

The distribution of the feed is an important consideration. It is not really necessary to feed the sheep every day. Feeding twice a week will suffice, though better results will be obtained by feeding three times a week. This greatly reduces the labour, but the whole of the week's ration should be distributed between the three feeds. However, it is inadvisable to treat ewes heavy in lamb this way.

Feed dumps which are protected from birds should be established close to feeding points and where more than one flock is being fed the feeding days may be alternated, thereby saving manpower.

There is no doubt that trough feeding is the most economical way of distributing the food. Obviously, troughs must be used when feeding meal or cracked grain. Troughs can be made from logs, galvanized iron or bags threaded on wires about 24 inches apart and from 8 to 12 inches from the ground. It is necessary to allow not less than 50 running feet of trough per 100 ewes heavy in lamb or with lambs at foot. One particular advantage of bag troughs is that sheep cannot become cast in them.

Plates 177 and 178 show the types of bag troughs commonly used. The advantage of the type shown in Plate 177 is that it can be filled from an automatic hopper fixed on the front of a truck (Plates 179 and 180. This greatly reduces the labour required in feeding and expedites the work.

Hay might be distributed by breaking up the bales on the ground (Plate 181) or fed from racks made by stretching 3-inch netting on posts set in the ground to form a V angle (Plates 182 and 183).

As success in drought feeding is largely dependent upon buying correctly, the composition of the rations fed to the sheep sometimes varies considerably with fluctuations in market prices. This calls for care in changing from one feed to another and it is advisable to do this gradually, allowing the sheep time to get used to the new food.

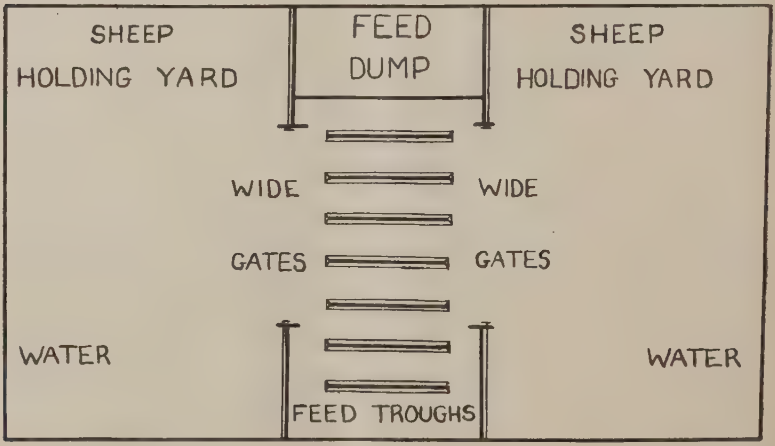
Flock Management in Relation to Drought Feeding.

Sometimes difficulty is experienced in teaching a flock to feed. Should it become necessary to feed, it is advisable to get a few sheep into a small yard and starve them for a day or so, but allow them adequate water. Then offer them some of the food which is to be used; it is often advisable to put a little fairly fresh lucerne or some palatable weeds such as thistles on top of the trough.

When they become accustomed eaters these sheep can be returned to the flock to act as "coaches." It is probable that some sheep will never become "feeders," and those which constantly refuse to eat may as well be turned out into whichever paddock has the best top feed.

In country where worm infestation is likely to occur it is always advisable to drench the sheep, preferably with phenothiazine, at the commencement of feeding.

The object in drought feeding is to maintain the sheep with the maximum economy. Under absolute drought conditions, when it is necessary to hand-feed completely, the sheep do not get enough food when wandering about the paddock to supply the energy requirements for walking. Accordingly, it is preferable to restrict the amount of walking and establish feeding yards near water (Plate 184). The flocks should be drafted according to strength and it is preferable to keep the animals in large shady yards with a set of feeding troughs from which the sheep can be excluded. The accompanying diagram suggests a suitable arrangement.



Alternatively, the troughs can be arranged as a long length as shown in Plate 177. This is necessary when they are filled from an automatic hopper fixed to a truck, as shown in Plates 179, 180, and 186. If an automatic hopper is not used it is preferable to distribute the feed from bags which are about half full. This makes handling easier.

Some idea of the amount of feed which can be saved by yarding the sheep as against allowing them to roam the paddock can be gained from the fact that it would require an additional half ton of maize per 1,000 sheep per week to provide for their walking six miles per day. Feeding near a reasonably salty bore is another way of keeping the sheep handy to the feeding points.

If the sheep are weak when feeding commences it is better to feed heavily for the first two weeks to strengthen the flock quickly. For this purpose maize is outstandingly good and it is better to use it almost irrespective of cost. Any additional expense incurred will be recouped subsequently in decreased losses of sheep. One-and-a-quarter times full feeding plus roughage is a reasonably safe level to suggest for the first two weeks' feeding. That is to say, increase 6 oz. of maize (or its equivalent) to about 8 oz. per head per day, 8 oz. of maize to 10 oz. of maize per head per day, or 12 oz. of maize to 16 oz. of maize or its equivalent per head per day. If there is a wide variation in the strength of the sheep when feeding is commenced it is advisable to draft on a strength basis immediately. If, on the other hand, the whole flock is weak this need not be done when feeding is commenced, but it is advisable to do so at the end of the first or second week of heavy feeding. Consideration can then be given to reducing the ration for the strong sheep but maintaining it for the weaker ones for a little longer.

Special care has to be taken in feeding lambing ewes. The most important principle is to wean early and feed the young sheep. It may be necessary to wean the lambs into yards, but this is preferable to letting them hang on the mothers. Creeps, which must be placed in the shade, may be used for a couple of weeks before weaning to encourage the lambs to eat. Once they are removed from their mothers they should be fed fairly heavily on a weight basis and roughage must be included in their diet. Lucerne, hulled oats and poultry growing mash are all useful for this purpose because of their high protein content. (Growth is essentially a period of protein storage.)

If the ewes are taken in hand prior to lambing and it is desired to save the lambs, it is advisable to feed the ewes a protein-rich meal to stimulate milk supply, but it is still advisable to wean early.

In cases where the sheep are very weak and the lambing poor, some owners prefer to sacrifice the lambs.

Very often the heaviest losses associated with drought feeding occur when the drought breaks. The precautions to take include:—

(i.) Maintaining a reasonable dump of feed close to the sheep so that feeding will not be interrupted through lack of supplies.

(ii.) Continue feeding (and it is preferable to use roughage for this purpose) until there is a reasonable body of feed—don't let the sheep chase a pick. The sheep will have to walk further to feed than their strength will permit.

(iii.) Do not let the flock scatter when it rains. This is not so bad if they are on good hard red country, except that they will probably go off chasing a pick. On black soil heavy losses can occur through bogging. If clouds come up and rain is promising it is advisable to feed the sheep into yards and/or the shed. This will prevent them scattering and the extra feed will probably be quite useful.

ACKNOWLEDGEMENTS.

It is desired to acknowledge the assistance of those woolgrowers who have placed all details pertaining to their experience with drought feeding at my disposal and to record the help given by Dr. M. White, of the Department of Agriculture and Stock.

It is also desired to thank Mr. S. L. Everist and Miss E. Baynes for permission to use unpublished data pertaining to Queensland's climatology.

Plate 177.
TROUGH FEEDING.—A length of 700 feet of bag troughing at "Neenah Park," Longreach.

Plate 178.
TROUGH FEEDING.—Short bag troughing used at "Rodney Downs," Ilfracombe.

Plate 179.

AUTOMATIC FEEDER MOUNTED ON TRUCK.—Designed and constructed by Mr. Eric Hudson, "Neenah Park," Longreach.

Plate 180.

AUTOMATIC FEEDING.—Another view of the feeder shown in Plate 179.

Plate 181.
SHEEP EATING LUCERNE HAY DISTRIBUTED ON THE GROUND.

Plate 182.
RACK FEEDING.—Wire netting hay rack designed by Mr. J. Y. Shannon and used at "Rodney Downs," Ilfracombe.

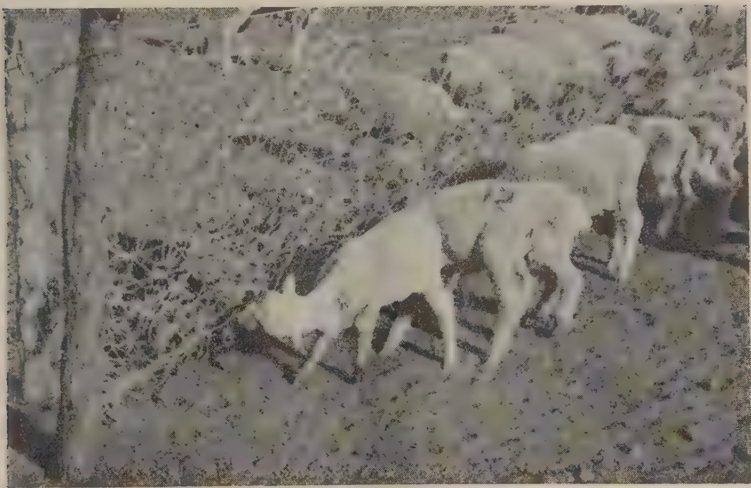


Plate 183.
RACK FEEDING.—Another view of the hay rack shown in Plate 182.

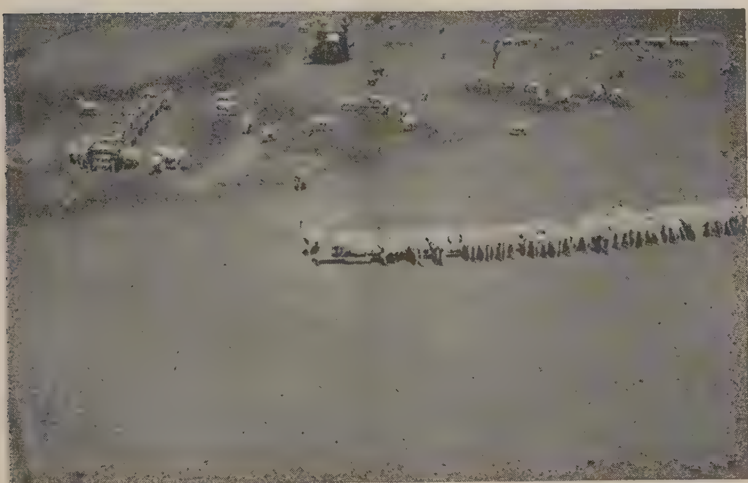


Plate 184.
TROUGH FEEDING SHEEP NEAR WATER.—"Neenah Park," Longreach.

Plate 185.

SHEEP FEEDING FROM LENGTH OF TROUGHING AND HAY BEING DISTRIBUTED FROM TRUCK.—"Neenah Park," Longreach.

Plate 186.

FILLING THE FEED TROUGHS FROM THE AUTOMATIC FEEDER MOUNTED ON A TRUCK.—"Neenah Park," Longreach.

Poultry Nutrition: Principles and Practices.

P. RUMBALL, Officer in Charge, Poultry Branch, and
F. N. J. MILNE, Assistant Husbandry Officer (Poultry).

MORE and more attention is being focused today on the question of feeding poultry. Added to the vagaries of supplies are high feeding costs, which necessitate the farmer making the most economical use of the materials at his disposal. This is only possible by ensuring that foodstuffs are not inadvertently squandered by underfeeding, by waste which is associated with the use of poor classes of feeding receptacles, by not using dietary supplements when they are necessary, and by the use of these expensive supplements when such are not needed.

It must be remembered that there have been and will be shortages of some of the ingredients in common use in poultry rations. This is due to the fact that some ingredients are the by-products of foodstuffs processed for human consumption. Over the past 20 years the human population of this State has hardly doubled itself. The poultry flocks, however, have increased at least tenfold, with the result that the by-products of processed human foods—that is, meatmeals, bran and pollard—have not increased in the proportion necessary to meet the requirements of this greatly expanded industry.

However, an intelligent study of the principles of poultry feeding and the application of these in the preparation of rations will ensure that poultry farmers obtain the utmost benefit from the foodstuffs available.

THE PURPOSE OF A POULTRY RATION.

The fowl can be regarded as a machine which converts the food consumed into eggs and flesh. How efficiently this is done depends on the inherited tendency for high production, on the type and quantity of food supplied to the bird, and on the general health and environment of the flock.

The purpose of a ration is twofold—firstly, the food furnishes heat, energy, and all the materials necessary for the upkeep of the body; and, secondly, it furnishes the materials for growth and production. From 75 to 80 per cent. of the feed consumed by a healthy bird on a full ration is normally used for the purpose of body maintenance.

The fowl differs from other farm animals in many ways, but particularly in the use of food. The hen has a higher body temperature (107 deg. F.) and exhibits greater activity than any other farm animal. As a result, the processes of digestion have of necessity to be speeded up. Hence, we find various adaptations to meet this need. Firstly, the hen's alimentary tract is short and not very complicated, and is best adapted for the proper use of more concentrated foods. Fowls have neither the capacity nor the structure to digest bulky feeds, such as is possible for a cow. Secondly, a hen eats in proportion to her weight more than twice as much dry matter in a given time as a cow, and uses food more efficiently than any other farm animal.

THE COMPOSITION OF A POULTRY RATION.

The ingredients of a normal poultry ration contain six basic compounds or nutrients—proteins (body-builders), carbohydrates and fats (energy-suppliers), minerals (skeleton, egg-shell), vitamins (utilisation of other nutrients), and water.

A good ration will contain all of these nutrients in such form and variety that proteins of the right type, minerals in proper proportion and in readily available form, and vitamins to bring about the proper assimilation of these elements are provided. Each of these will be considered in detail.

Proteins.

Proteins, along with carbohydrates and fats, are the important constituents of the protoplasm of the living cells and as such form important components of bones, ligaments, soft tissues, muscles, feathers, nails, beaks and skin. They form the nitrogenous part of the food and are mainly used for growth, repair of waste tissue, and production.

Just as a brick is made up of a number of different constituents, so is protein composed of a number of smaller units—all chemically linked together—known as amino-acids. These amino-acids in turn are composed of atoms of carbon, hydrogen, oxygen, nitrogen and sometimes sulphur, phosphorus and iron. Sulphur-containing amino-acids are found in hard external features of the fowl—feathers, nails, scales and beaks.

Twenty-five amino-acids have so far been identified. Most animals are capable of synthesising (manufacturing) some of the amino-acids. Those which cannot be synthesised must be supplied in the diet. These amino-acids are known as the "essential amino-acids." Some of these amino-acids are synthesised by the animal, but are not manufactured quickly enough or in sufficient quantity to satisfy the requirements of the animal: for example, glycine, although synthesised by the fowl, cannot be synthesised rapidly enough to promote growth; it is obvious that glycine must be supplied in the diet. Of the 25 amino-acids so far identified, 11 are absolutely essential to poultry.

On digestion, the proteins are split into smaller and smaller fragments by the action of protein-splitting enzymes. This process is continued until the amino-acid stage is reached. These amino-acids are absorbed through the gut wall and transported to the liver, which is also capable of amino-acid synthesis.

From the liver the amino-acids are carried in the blood stream to all parts of the body where the specific proteins required for growth and repair of tissues are manufactured.

Amino-acids thus derived from these two sources—that is, from the diet and from the liver—are recombined to form the specific body proteins. This is only possible if all of the amino-acids are present. The absence of even one amino-acid group will be reflected in retarded growth and production.

While a diet deficient in protein is deleterious, feeding in excess of body and egg-producing requirements is wasteful and can be harmful. Excess amino-acids are dealt with by the liver in the following ways:—(1) By conversion of amino-acids into carbohydrates or "blood" sugar, which can be utilised for energy production; (2) by conversion into fat, which is stored and used for energy production as the occasion demands; and (3) by the conversion of the nitrogenous portion of the amino-acid into excretory products—urates.

The feeding of excess protein therefore leads to a greater production of urates, which may be deposited in the kidney or liver, thus impairing normal protein digestion, assimilation and excretion.

Most of the essential amino-acids are found in animal tissues and at a sufficiently high level to supplement the vegetable protein—hence the importance of feeds of animal origin. It has been recommended by at least one authority that 20 per cent. of the protein content of a ration should be of animal origin.

Cereals, particularly maize, are low in some of the essential amino-acids, but what is lacking in one cereal may be made up by the use of another containing those amino-acids. Therefore an intelligent combination of grains with the use of animal protein will ensure that no amino-acid deficiencies exist.

Protein Levels.

Growing birds require large quantities of protein. Laying hens, although their requirements for growth are less, must have sufficient to meet the heavy demands of egg-production. In the case of young laying pullets, provision must also be made for an adequate supply of protein, as active growth is still in progress.

Research into the feeding of different levels of protein in poultry rations at different stages to attain optimum growth was conducted by the Queensland Department of Agriculture and Stock from 1931 to 1935.

The graph in Plate 187 shows the growth rates of two groups of White Leghorn chickens on high- and low-protein diets, the protein levels being 17.15 per cent. and 15.01 per cent. respectively. The best results were obtained when the higher protein diet was fed during the first six to eight weeks.

For young growing chickens a further series of experiments showed that the optimum percentage of protein in the ration lies above 18, and protein levels from 18 to 20 per cent. during the first six to eight weeks give a greater gain in weight.

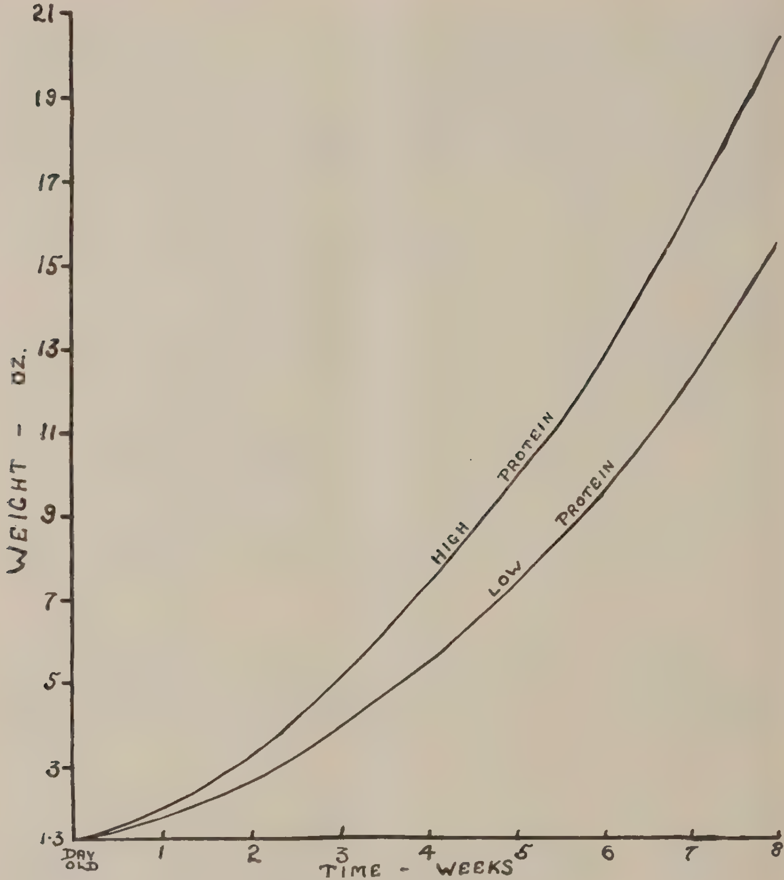


Plate 187.

As the birds near maturity this high level can be lowered—a gradual reduction by feeding increased quantities of grain—to between 15 and 16 per cent. The protein requirement of a chicken does not alter as sharply as this, but these periods and protein content are suggested as meeting the practical requirements of the poultry raiser.

Insufficient Protein.

Growth is retarded, sexual activity may be delayed and eventual egg production affected if insufficient protein is fed. Some workers have also observed cannibalism and feather picking amongst growing stock on a protein-deficient ration.

Excess Protein.

A protein level of 30 per cent., in addition to being wasteful, has been found to be toxic to growing stock. This toxicity is due, no doubt, to the overloading of the excretory organs by the accumulation of urates.

Carbohydrates.

Carbon, hydrogen and oxygen are the elements which, in chemical combination, form the carbohydrates. There are two classes of carbohydrates—the sugars, which include the more complex forms such as starch, and cellulose or fibre.

During the process of digestion, particularly in the higher animals, the starches and sugars are broken down and converted into simple sugars, which are absorbed through the gut wall into the blood stream and conveyed to the liver and muscles.

Their function is to provide energy for (*a*) movement, (*b*) maintaining the correct body temperature, (*c*) supplying the vital body processes such as the beating of the heart, and (*d*) the functioning of the organs of respiration and the alimentary canal.

Only after these requirements have been met can the excess carbohydrates be utilised for egg-production. Any excess beyond this in the laying bird would be converted into fat and stored in the body. Some of the surplus may also be converted into glycogen or animal starch and stored in the liver and muscles. This can be reconverted into glucose when the level of blood sugar falls below a certain limit.

Fibre or cellulose is derived from the plant cell walls. It cannot be fully utilised by the fowl, for research has shown that no cellulose-splitting enzyme exists in the fowl's digestive juices. There is little time available for digestion; hence little or no conversion to the simpler carbohydrates is possible.

Carbohydrate Levels.

A shortage of carbohydrate is never likely to occur in poultry rations, because of the high percentage of grains fed either whole or as meal.

Fibre Levels.

While fibre contributes little or nothing to the digestible nutrient part of a ration, it plays an important part in the efficiency of digestion. A ration containing less than 5 per cent. of fibre becomes compacted, with the result that the digestive juices do not mix intimately with the food.

A very fibrous ration (above 9 per cent.) not only reduces the amount of food eaten owing to its bulk, but also irritates the intestines and impairs digestion, and thus production. The most desirable fibre level is approximately 7 per cent.

Fats.

Carbon, hydrogen and oxygen, as in carbohydrates, form the essential elements of fats. They are also energy-suppliers and, weight for weight, when utilised within the body, liberate 2¼ times as much energy as carbohydrates. Body fat is derived from the diet directly from the fat present and indirectly from the conversion of excess carbohydrates and protein above the body and egg-producing requirements. The conversion of protein is a one-way process. Thus, a ration deficient in protein, no matter how rich in fats and carbohydrates, cannot give adequate growth.

The presence of a moderate amount of fat in the diet probably has a beneficial influence on the absorption of calcium and phosphorus, since the fatty acids maintain a favourable acidity in the intestinal contents. This state of acidity helps to keep these minerals in solution.

There is a certain optimum level, for dietary research has shown that a diet containing a high percentage of free fatty acids—for example, rancid meatmeal—exerts an adverse effect on growth and feed consumption of chicks. In any case, in the present state of our knowledge, a fat content higher than 5 per cent. cannot be recommended.

Minerals.

Minerals are often referred to collectively as ash, which is that portion of a plant or animal which is left after burning. Minerals enter into practically all functions of the body, and in particular into the formation of bone and egg-shell.

Of major importance as far as quantity required and direct influence are calcium and phosphorus. In addition, certain other minerals, though occurring only in minute amounts, are directly responsible for the normal well-being of the fowl. These are known as "trace elements" and will be dealt with later.

Calcium and Phosphorus.

The formation of the bony skeleton and egg-shells is dependent upon the availability of sufficient quantities of calcium and phosphorus in the ration. The laying hen is entirely dependent upon dietary calcium and phosphorus, for, if the supply were stopped, there would be only enough calcium and phosphorus available from the skeleton to provide about three or four eggs. Grains and their by-products, which form the bulk of poultry rations, are deficient in both of these minerals. In addition, most of the phosphorus present in grains is combined with another organic substance as phytin and in this form cannot be assimilated by the fowl.

It is therefore essential that both of these elements be supplied in the ration. Animal by-products—meat and bone meals—supply phosphorus and some calcium, while calcium is derived also from limestone or shell grit supplied either separately or incorporated, in powdered form, in the mash.

The ratio between the amounts of calcium and phosphorus in a ration is a very important factor, since an excess of one may result in a depletion of the other—for example, an excess of calcium may cause some of the calcium to combine with the phosphorus in the gut to form an insoluble compound, calcium triphosphate. The excess of calcium may also hinder the absorption of manganese.

Much research has been carried out to determine the proper balance for calcium and phosphorus in the diet. It has been found to closely approximate the ratio in which these two minerals occur in the bony skeleton, namely 2:1.

Starting and growing rations should contain at least 1 per cent. calcium and 0.6 per cent. phosphorus. Layers and breeders require at least .75 per cent. phosphorus, with the calcium level at two to three times this value.

However, even if a perfect calcium/phosphorus balance is struck, there will be poor utilisation unless vitamin D is present. This inter-relationship will be discussed when dealing with vitamins.

Trace Elements.

In addition to calcium and phosphorus, which are supplied in relatively large quantities, minute amounts of certain minerals are needed for the general well-being of the bird.

Manganese.—There is ample and increasing evidence of the great practical importance of manganese in poultry nutrition. It was first shown that manganese had a direct bearing on the incidence of perosis or "slipped tendon" in poultry. Today we know that it also plays a major part in successful bone formation, egg-shell structure and hatchability. Poultry farmers must be ready to guard against a deficiency of this mineral because bran and pollard, both naturally rich sources of manganese, are very often in short supply. In addition, the manganese content of whole grains varies considerably, not only between different types of grains but within the same kind. Wheat averages about 39 parts per million as against 5 parts per million found in maize. Research workers in Western Australia carried out manganese estimations on 208 samples of wheat. The range varied from 19 to 84 p.p.m. with a mean value of 37 p.p.m.

From the foregoing it can be seen that more and more attention must be paid to meeting the manganese requirements of poultry. The nutritional requirements for light breeds is set down as 40 p.p.m., and for heavy breeds as 50 p.p.m.

It is suggested that to guard against any possible deficiency (900 p.p.m. of manganese have been fed before toxicity results) 4 oz. of manganese sulphate be added to every ton of mash. This can be incorporated by first mixing it intimately with the salt.

Iron and Copper.—Iron is required for the formation of haemoglobin, the oxygen-carrying compound of the red blood cells. This formation cannot take place unless traces of copper are present. Thus a diet deficient in either of these minerals gives a poor development of blood cells, with resultant nutritional anaemia.

In the laying hen, the demand for iron and copper for egg formation is increased, since the average egg yolk contains 0.0143 per cent. iron and .00076 per cent. copper; hence the ration must contain an adequate amount. In some cases where plenty of green feed is not available iron supplements may be necessary.

Generally speaking, dietary needs, especially in young chickens, are covered adequately by feeding iron-rich young greenstuffs (lucerne meal and cereals) and iron-rich animal proteins in animal by-products.

One danger which has to be faced when supplementing a ration with iron-containing compounds is that too great an excess of iron will interfere with the absorption of phosphorus. Rickets have been produced experimentally by feeding high levels of iron supplements.

Sodium Chloride (Salt).—Common salt plays a vital function in the physiology of the fowl. It forms a considerable part of the straw-coloured fluid or plasma of whole blood. Salt is also required for the manufacture by the fowl of hydrochloric acid, which is secreted in the

stomach. Inclusion of salt up to 1 per cent. of the mash is recommended. An excess may cause salt poisoning, as salt in too great a quantity is extremely toxic to fowls.

Vitamins.

Vitamins are complicated chemical substances essential in minute quantities for normal life. A ration otherwise perfect but lacking certain of these vitamins will lead to disastrous results. Of the vitamins playing an important role in poultry nutrition, vitamin A is probably of the greatest importance. The vitamins are classified broadly into two groups—the fat-soluble (A, D, E and K) and the water-soluble (B complex).

Vitamin A.

Vitamin A is the most important vitamin in poultry nutrition and its deficiency one of the most common diseases in this State. It is of paramount importance because it enters into every phase of the bird's life and the functioning of its life processes. In breeding stock it is necessary for good production, fertility and hatchability. In chickens and growing stock it promotes growth and health, appetite and digestion, and increases resistance to many infectious diseases, particularly those of a respiratory nature. Recently it has been shown that mortality due to coccidiosis is far greater amongst chickens on a vitamin A deficient diet than in those on an adequate ration.

In severe cases, lack of this vitamin leads to the drying-up and hardening of the membranes covering the eye and the trachea, giving the typical "eye roup" condition of poultry and pustules in the pharynx.

The kidneys may also be affected. They may be enlarged and whitish in appearance, due to accumulation of urates.

There is lowered resistance to parasites, particularly to round worms harbouring in the alimentary canal. Many a post-mortem has revealed a vitamin A deficiency complicated by the presence of a heavy infestation of round worms.

All green plants, particularly fresh green lucerne, and lucerne leaf meal are rich in vitamin A. Vitamin A is present in the form of carotene, which is converted into vitamin A in the body. It is often called provitamin A. Fresh green lucerne hay has about five times as much vitamin A as yellow maize, another good source.

Lucerne, as hay, chaff or meal, loses a lot of its vitamin A content on being stored. Bran and whole wheat contain very small amounts. Fish oils are an excellent source of vitamin A, but they should be valued on their vitamin content, which is variable. The amount of green colouring in freshly cured fodder crops is an indication of their vitamin A content.

Fresh green feed is by far the most economical source of vitamin A. Failing that, a ration containing at least 30 per cent. of yellow maize and 5 per cent. of choice fine-cut lucerne chaff or lucerne meal should meet the needs of layers. If no yellow maize is available, then up to 10 per cent. of lucerne should be fed. Cod-liver oil or other approved fish oil is at times unprocurable, but when available 1 per cent. of a good

grade containing 1,000 I.U. per gram may be added to the ration to supply vitamin A. More concentrated forms of fish oil with a higher vitamin A potency are also available. In this case smaller amounts will be required. Fish oil, however, is generally costly compared with fresh green feed or lucerne chaff. Further, the lucerne or green feed provides other valuable food factors. A regular supply of 5-6 lb. of green feed per 100 hens per day is recommended.

Vitamin A is a very unstable substance. It is destroyed by excessive heating and exposure to air, due to oxidation. For this reason it is unwise to store mashes to which fish oils have been added for any length of time, as the vitamin A content decreases rapidly. It has also been found that charcoal in the mash can have a deleterious effect on vitamin A.

Vitamin D.

Vitamin D aids the assimilation and utilisation of calcium and phosphorus. Lack of this vitamin, even though the dietary levels of calcium and phosphorus are adequate, will result in poor bone formation and death in growing stock (that is, rickets) and the production of thin and soft-shelled eggs in layers. Hatchability as a result would also be seriously affected.

Two sources of vitamin D are available. For birds housed intensively it is essential to add a fish oil containing vitamin D to the ration. If fowls have sufficient exposure to sunlight, there is little likelihood of a vitamin D deficiency, since the ultraviolet rays of sunlight convert substances in the skin and feathers of the fowl into vitamin D and adequately supply the bird's requirements.

The term vitamin D actually embraces several related compounds. Two of these are of interest in poultry nutrition—namely, vitamin D_2 and vitamin D_3. The first form of vitamin D, known as calciferol, can be utilised by the rat but not by the fowl. Vitamin D_3, the naturally occurring form of vitamin D, is fully utilised by the chick.

This vitamin is much more stable than Vitamin A, being very resistant to heat, oxidation, and storage.

Vitamin E.

Vitamin E, though not necessary for egg production in laying hens, is necessary for embryonic development. One of the most striking symptoms of vitamin E deficiency in growing stock is "crazy chick" disease, which may or may not have a sudden onset.

The vitamin is found in large quantities in wheat germ and meal, and to a lesser degree in pollard, fresh green feed, good quality lucerne meal or chaff, and whole grains.

As yet probable quantitative requirements for poultry have not been determined, but most good rations appear to be adequate in vitamin E.

It is relatively stable to heat but is rapidly destroyed in the presence of fats which go rancid. This may occur when poor quality meatmeal or poor quality fish oil is incorporated in a mash.

Vitamin K.

Vitamin K, known as the anti-haemorrhagic vitamin, is of importance in the clotting of blood. Lack of this vitamin increases the time taken for blood to coagulate and therefore increases the probability of mortality through injury.

Lucerne meal, green feed, liver meal, and meatmeal are the chief sources. Good quality lucerne fed at a 2 per cent. level will satisfy the vitamin K requirements of poultry.

Vitamin B_1 (Thiamin or Aneurin).

This vitamin is essential to the fowl for the promotion of appetite, digestion and growth, aid in resistance to parasites, and maintenance of normal excretion. It is present in so many ingredients of ordinary poultry rations, including grains and their by-products and fresh and dried green feeds, that a deficiency of the vitamin is very unlikely to occur.

Vitamin B_2 (Riboflavin).

Riboflavin is essential for growth, health, and body maintenance. Its deficiency causes ''curled-toe paralysis,'' usually at about 3 to 4 weeks of age. In adult hens a deficiency of the vitamin causes a drop in egg production and a marked reduction in hatchability. Many embryoes develop to an advanced age but die in the shell.

The vitamin is present in dried yeast, dried whey, skimmed milk, buttermilk powder, lucerne hay and meal, soybean meal, pollard, bran, maize, cottonseed meal, and animal protein.

Dried yeast and liver meals have the highest riboflavin content, but if these are unavailable milk powders (dried buttermilk or dried whey) constitute the best supplements with which to fortify any ration. The synthetic product can now be obtained and is equally effective for all purposes.

Niacin.

Niacin, the pellagra-preventive factor, is necessary for normal growth, egg-production, and the prevention of inflammation in the mouth and crop. Excellent sources of niacin are liver meals, brewer's yeast, wheat bran, and lucerne leaf meal. Maize, oats, peanut and soybean meal are poor sources.

Pantothenic Acid.

Pantothenic acid must be present in the diet of chickens to ensure normal growth, development, feathering, and the prevention of skin disorders (dermatosis). Chicks with dermatosis have scabbing in the corner of the mouth, and their eyelids become thickened and may stick together. Cracks may appear in the feet. These symptoms usually occur at approximately 3 to 4 weeks of age.

Milk by-products, yeast, liver meal, molasses, lucerne meal, and wheat by-products are good sources of this vitamin.

Pyridoxin (Vitamin B_6).

Pyridoxin is necessary for growth and maintenance of appetite and the prevention of a certain type of convulsions. Chicks fed a pyridoxin-deficient diet show a small initial gain, then cease to grow or grow very slowly. Some chicks show abnormal excitability, spasmodic convulsions and sometimes twisted and retracted necks.

Pyridoxin deficiency in mature birds is characterised by loss of appetite, followed by rapid loss of weight and death. Egg production and hatchability are reduced markedly.

Pyridoxin is found in cereal grains, bran, pollard, liver meal, yeast, fresh green feed, and lucerne meal.

Biotin.

Biotin is necessary for growth and hatchability. It is also involved together with manganese and choline in the prevention of "slipped tendon" or perosis.

In biotin deficiency in chicks skin disorders first appear at about 3 weeks of age. These lesions are very similar to those occurring in pantothenic acid deficiency.

The chief sources of biotin in the ration are grains, liver, molasses, lucerne meal, and fresh green feed.

Choline.

Choline is necessary for growth, bone development and egg production. A lack of choline in the diet of young chickens and turkeys results in retarded growth and perosis. It has also been noted that in the relative absence of choline there has been marked fatty infiltration of the liver.

Good sources of choline are grains, wheat by-products, meat and liver meals, milk products, and peanut meal.

Folic Acid.

Growing chicks must have a little-known and only recently discovered vitamin called folic acid for normal growth, feathering and blood-building. Latest information on the sources of this vitamin indicates that the leafy parts of plants, liver meal, and yeast are good sources, while cereal grains and by-products, linseed meal, and meatmeal also contain the vitamin in appreciable amounts.

It is indeed significant to know that the vitamins discussed are also essential in human nutrition and are found to a greater or lesser concentration in poultry products, both eggs and flesh.

Thus if these factors are present in the feed, it is obvious that not only are poultry supplied with their essential vitamins but that the resulting product will also be of greater nutritive value.

[TO BE CONTINUED.]

MARKETING

The Development of the Wheat-growing Industry in Queensland.

C. H. DEFRIES, Assistant Director of Marketing.

APART from its dominant position in certain summer grains, such as maize, sorghum, millets, &c., Queensland has never been regarded as a grain-producing State, and the rapid progress now being made by the wheat industry, together with such enterprises as the Queensland-British Food Corporation's sorghum-growing project in Central Queensland, is therefore of particular significance in the assessment of the future of agricultural production in Queensland.

Queensland has always been essentially a pastoral State and no extensive grain industries developed as they did in other parts of Australia subsequent to the gold rush in the middle of last century, to be followed later by advances in the technique of harvesting, transport and marketing that made Australia a major wheat-exporting country.

Natural conditions in Queensland are such that the pastoral industry will continue to maintain its status and importance in the rural economy, but recent developments give rise to the hope that there will be in the future a closer association between the grain, pastoral and other industries.

The expansion of the wheat industry in Queensland, together with the enactment late in 1948 of legislation by the Governments of the Commonwealth and States to give effect to an Australia-wide scheme of wheat industry stabilisation and marketing, provides an opportune time to outline the salient features of the development of the industry in the States that will, it is hoped, afford a background against which to examine the problems with which it is confronted.

Peculiarities of the Queensland Wheat Industry.

A review of this nature is particularly desirable at this period of expansion because the wheat industry in Queensland has certain peculiarities which distinguish it from the industry in other States. These may be briefly summarised as follows:—

(*a*) In the past, the crop in Queensland was confined, to an important degree, to the status of a relatively minor component of mixed farming in which dairying and, to a lesser extent, sheep raising, were the major activities. However, there has been a marked shift of emphasis from the valleys of the south-eastern Downs to the more extensive areas of the north-western and western Downs which have become available since the destruction of prickly-pear by Cactoblastis. This may be contrasted with the position in other States, where the area tends to contract with the elimination of the marginal country.

(*b*) Wheat growing in Queensland is subject to greater hazard than obtains in the main wheat areas of the southern States since the rainfall is predominantly summer in its incidence. However, widespread mechanisation and the development of suitable varieties have been influential in overcoming many of the risks involved.

(*c*) Queensland wheats have been found to possess superior qualities for flour milling, and thus are in a position to command a premium market as compared with f.a.q. wheat.

(*d*) The industry has gained material advantages by reason of the operations of the Queensland State Wheat Board, which was set up by *The Wheat Pool Act* on 2nd December, 1920, and which was the forerunner of the many commodity marketing boards established for other industries under State marketing legislation.

These matters are dealt with in greater detail in the notes below.

Growth of the Industry.

The past two seasons have resulted in record wheat crops of 10½ and 14 million bushels respectively, but it is as well to note that this rapid change from a position where the State did not produce sufficient wheat for local consumption needs to one where a substantial surplus becomes available for export is essentially a resumption of a pre-war trend influenced primarily by the availability of new varieties, mechanisation, and the new lands opened up by the destruction of prickly pear.

However, until the years immediately prior to the second world war the industry was essentially made up of small-scale enterprises associated mainly with the dairying and, to a lesser extent, the sheep industries.

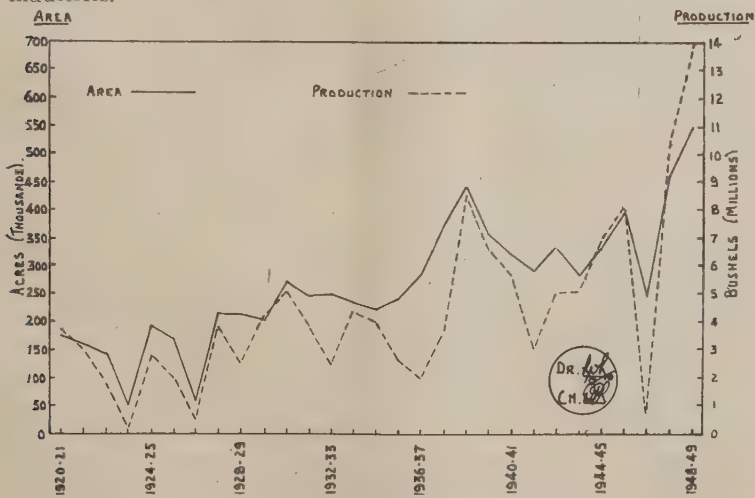


Plate 188.

WHEAT IN QUEENSLAND.—Graph showing area planted to wheat for grain and grain production, 1920-21 to 1948-49.

Plate 188 shows the trend of plantings and production since 1920-21. Of particular interest is the steady expansion of acreage just prior to the war, the decline during the war years, and the recovery that is now taking place. The fall in acreage in the 1946-47 season was due to severe drought conditions, which prevented planting in many areas.

Briefly to review the growth of the industry, statistical records show that in the 1860-61 season Queensland grew 196 acres and produced 3,140 bushels of wheat. Just prior to the 1914-18 war the industry had developed to the extent of producing $1\frac{3}{4}$ million bushels from 130,000 acres, or $1\frac{3}{4}$ per cent. of Australian production. Although production increased up to the 1916-17 season as a result of the "Grow More Wheat" campaign during the first world war, fluctuating prices in the later years of the war and scarcity of labour reduced profits from wheat growing, and there was a very sharp decline in production up to 1918-19, when only 22,000 acres were planted.

At this period the industry was concentrated on the southern and central Darling Downs; the crop was grown to a significant extent for grazing or hay, and only in favourable seasons was it harvested for grain. This, of course, still applies to a large extent to these particular areas, but they are not now so representative of the wheat districts as a whole. Moreover, variations in the differential between the profits from wheat growing and profits from dairying had a marked influence on the production of wheat for grain on individual farms.

The fluctuations of the early post-war years clearly show the effects of these variations. They continued during the depression years of the early 1930's, when the drastic fall in the price of wheat influenced many farmers to engage more exclusively in stock-raising activities, particularly dairying, than in growing crops for grain. In 1932-33, for instance, of 1,927 farms growing wheat in Queensland, only 500 were growing over 100 acres of wheat. However, it is of interest to note that following an increase to 272,000 acres in the 1930-31 season, due in fact to another "Grow More Wheat" campaign, the acreage fell back only to 250,000 acres in the following year despite the price collapse, and remained fairly constant until the 1937-38 season, when the major expansion commenced. Apparently some farmers compensated for the fall in prices by increasing the area planted in order to maintain turnover in an effort to meet fixed commitments. This served to offset the reduced areas of those who turned to dairying.

By 1935 land that had been reclaimed from prickly pear was becoming available, and increased acreages resulted. This continued until the 1938-39 season, when 450,000 acres were harvested for grain. This expansion was interrupted by the war and recovery was very slow until the 1947-48 season, when the area harvested totalled 469,462 acres. A further increase to 550,000 acres for the 1948-49 season indicated that the strong upward trend had been resumed.

During the war many factors limited the trend toward expansion. The stabilisation plan initiated early in the war years limited acreage to a pre-war basis, and although this restriction was later relaxed as far as Queensland was concerned the imposition of the quota plan, which provided for a guaranteed price restricted to the first 3,000 bushels produced on a farm, had the effect of diverting some farm resources to the livestock industries. As the war progressed other factors also began to be felt, and labour, fuel and machinery shortages effectively prevented

expansion even when the relaxation of controls of acreage and the increased prices for wheat overseas might otherwise have encouraged increased production.

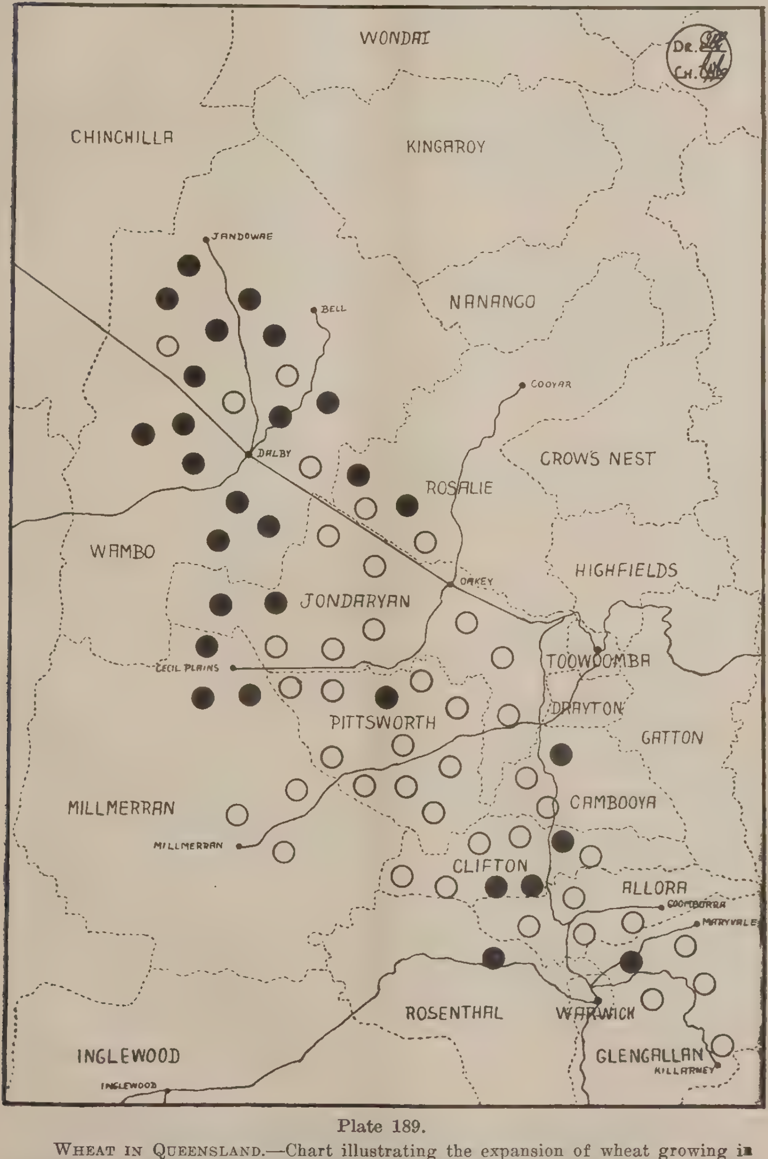


Plate 189.

WHEAT IN QUEENSLAND.—Chart illustrating the expansion of wheat growing in north-western Downs areas. Each circle represents 5,000 acres; the white circles represent acreages sown in the 1935-36 season and the black circles the additional acreages sown in the 1945-46 season.

The developments that have since taken place have brought the industry to a stage where Queensland will provide the 7-8 million bushels required for local consumption and also have a regular surplus of high quality grain available for export. Table 1 gives a further illustration of the trends outlined above.

TABLE 1.

WHEAT FOR GRAIN—QUEENSLAND.

Area, Production and Yield per Acre, 1920–21 TO 1948–49.

(*Source—Commonwealth Production Statistics.*)

Year.	Area.	Production.	Yield per Acre.
	Acres.	Bushels.	Bushels.
5 Year Average, 1920–21 to 1924–25	145,555	2,326,904	15·99
5 Year Average, 1925–26 to 1929–30	172,068	2,577,427	14·98
5 Year Average, 1930–31 to 1934–35	244,986	3,980,630	16·25
1935–36	239,631	2,690,316	11·23
1936–37	283,648	2,016,236	7·11
1937–38	372,935	3,749,443	10·05
1938–39	442,017	8,583,736	19·42
1939–40	362,044	6,794,906	18·77
1940–41	322,081	5,687,350	17·66
1941–42	290,801	3,079,898	10·59
1942–43	334,785	5,005,065	14·95
1943–44	281,302	5,084,292	18·07
1944–45	332,365	6,980,766	21·00
1945–46	392,502	8,187,687	20·86
1946–47	247,996 (*a*)	704,835 (*a*)	2·84 (*a*)
1947–48	462,239 (*a*)	10,684,563 (*a*)	23·11 (*a*)
1948–49	550,000 (*b*)	14,000,000 (*b*)	23·64 (*b*)

(*a*) Source—Queensland Government Statistician.
(*b*) Preliminary estimate—subject to revision.

Location.

Wheat production is mainly concentrated in the area known as the Darling Downs, with relatively smaller areas along the western line to Roma and an isolated area located in the Central District. What is of great significance, however, is the very marked transition, as mentioned earlier, that has taken place from the south-eastern Downs to the plains country of the north-western Downs. Plate 189 highlights the changes that have taken place on the Downs.

From Plate 189 it will be seen that there has been a degree of expansion over the whole wheat area but that the major emphasis has shifted to the north-west. Lately there has also been a substantial expansion in the areas further west toward Jackson and Dulacca, on the western Downs.

The influences that have made this transition possible are as follows:—

(*a*) Developments such as those relating to mechanisation and improved cultural and harvesting machinery, and the improved production technique thereby rendered possible;

(*b*) The breeding of suitable varieties for growing under Queensland conditions;

(*c*) The large tracts of land that became available when the prickly pear lands were cleared.

Mechanisation.

Wheat tends to be a hazardous crop under Queensland climatic conditions, and a major essential in wheat culture is rapidity of operation throughout the cultivation, seeding and harvest periods. Horses as a source of power are suitable only for small areas, particularly with the high temperatures that prevail, and it was not until mechanised power became available that the difficult climatic conditions could be overcome on large areas.

The predominance of summer rainfall has led to the adoption of a comparatively short fallow period during the summer months as distinct from the long fallows of the southern Australian wheat areas. Rapid destruction of weed growth during the summer months is aimed at in order to permit a suitable seed-bed to be established for the planting season from April to July. Moreover, with the comparatively light winter rains planting itself is usually carried out under considerable pressure of time.

For this to be satisfactorily accomplished the emphasis has at all times to be placed on speed of operation. The time factor is all-important and this has meant in effect that successful wheat farming on any large scale has been confined to the mechanised farm, which, of course, requires a sufficiently large area of wheat and/or other grains for worthwhile economic operation.

This phase of wheat growing has a significant bearing on the present expansionist stage of the industry. Speed of operation implies not merely mechanisation but the provision of sufficiently high-powered tractors to cope with the severe strain of continuous operation carried out under great pressure. The most serious tractor shortage of the war and post-war years has in fact been in just these high-powered machines that are required by the wheat industry in this State. Moreover, as the years go by with inadequate replacement of worn-out machines, the effort to carry out speedy cultivation suffers from the need to locate and fit spare parts and effect necessary repairs.

Thus, even now, expansion is being retarded to an incalculable extent by reason of the impossibility of obtaining sufficient suitable machinery for new areas and of obtaining the heavier types of tractor needed both for the replacement of old machines and for the speedy cultivation of increased areas on the individual farm.

Supplies of farm machinery other than tractors have improved of late years, but again shortages have influenced to some degree the extent of the possible expansion. Although it is quite impossible to measure the effect of such shortages it can safely be forecast that the ready availability of tractors of a suitable type and other farm machinery would result in a further impetus to wheat production.

Plant Breeding.

Many of the varieties introduced from other States in the early years were found unsuitable for Queensland conditions. Not until the release subsequent to 1920 of those varieties which resulted from the

work of Mr. R. E. Soutter, of the Queensland Department of Agriculture and Stock, were varieties available for general cultivation that were adapted to the peculiar climatic conditions in the man wheat areas. The question of wheat variety, together with its associated subject of wheat quality, is of particular importance to Queensland, and is dealt with in a later section.

Prickly-pear Lands.

Even with improved varieties and the advantages of mechanization, expansion could not have taken place without suitable land, and this was not available in quantity until the prickly-pear lands were freed as a result of the control of this weed by the caterpillar of the moth *Cactoblastis cactorum*. The destruction of this growth by Cactoblastis is said to provide the most dramatic and important example of biological control of weed growth in the world.

Captain Arthur Phillip is reported to have introduced prickly pear to Australia in 1788 from Rio de Janeiro in order to provide a dye for soldiers' coats from the cochineal insects with which the pear was infested. By 1901 the Queensland Government was offering a prize of £5,000, which was increased to £10,000 in 1907, to any person who could devise a means of eradicating the pest. By 1925 it was estimated that an area of 60,000,000 acres was densely infested with pear, of which 30,000 acres were useless from a production point of view.

Various methods of control, such as arsenical poisons and mechanical controls, were tried and some success was attained in small areas, but none effectively controlled the pear and prevented its spread to other areas until the advent of the caterpillar of the moth *Cactoblastis cactorum*. This was first introduced into Australia in 1912 by Mr. Henry Tryon, the then Government Entomologist. The moths were brought from La Plata, in Uruguay, but died before any knowledge was obtained as to their value, and were not reintroduced until 11 years later.

Experiments were conducted with these insects at a field station at Chinchilla, and in 1926 it became apparent that a solution to the problem might be in sight. A total of two billion eggs was released through official sources in Queensland between 1929 and 1930. The rapid destruction of the pear was followed by the virtual dying out of the moth because of the vanished food supply and regrowth of prickly pear took place very rapidly. By 1934, however, it was obvious that the insect had the capacity to build up its population faster even than the pear and it definitely gained the ascendency, which it has maintained ever since.

Much of this land was heavily timbered, mainly by brigalow and belah scrubs or eucalyptus forests, but when cleared, fenced and watered it was found to be highly productive for both pastoral and agricultural purposes.

[TO BE CONTINUED.]

ASTRONOMICAL DATA FOR QUEENSLAND.

JULY, 1949.

Supplied by W. J. Newell, Hon. Secretary of the Astronomical Society of Queensland.

TIMES OF SUNRISE AND SUNSET.

At Brisbane.			MINUTES LATER THAN BRISBANE AT OTHER PLACES.					
Day.	Rise.	Set.	Place.	Rise.	Set.	Place.	Rise.	Set.
	a.m.	p.m.						
1	6.39	5.03	Cairns	8	50	Longreach	26	43
6	6.39	5.05	Charleville ..	25	29	Quilpie	37	33
11	6.39	5.07	Cloncurry	36	63	Rockhampton ..	0	19
16	6.38	5.10	Cunnamulla ..	32	27	Roma	15	19
21	6.38	5.12	Dirranbandi ..	22	16	Townsville ..	8	42
26	6.34	5.15	Emerald	11	28	Winton	29	52
31	6.31	5.17	Hughenden ..	21	49	Warwick	5	4

TIMES OF MOONRISE AND MOONSET.

At Brisbane.

Day.	Rise.	Set.
	a.m.	p.m.
1	10.23	10.01
2	10.57	11.05
3	11.31	..
	p.m.	a.m.
4	12.04	12.08
5	12.40	1.12
6	1·19	2.17
7	2.04	3.23
8	2.55	4.30
9	3.52	5.34
10	4.52	6.33
11	5.54	7.25
12	6.55	8.09
13	7.53	8.47
14	8.48	9.20
15	9.42	9.49
16	10.34	10.16
17	11.25	10.44
18	..	11.11
	a.m.	
19	12.18	11.40
		p.m.
20	1.13	12.12
21	2·10	12.50
22	3.09	1.34
23	4.10	2.25
24	5.10	3.24
25	6·06	4.28
26	6.57	5.36
27	7.42	6.45
28	8.21	7.51
29	8.58	8.57
30	9.32	10.01
31	10·06	11.05

MINUTES LATER THAN BRISBANE (SOUTHERN DISTRICTS).

Charleville 27; Cunnamulla 29; Dirranbandi 19; Quilpie 35; Roma 17; Warwick 4.

MINUTES LATER THAN BRISBANE (CENTRAL DISTRICTS).

Day.	Emerald.		Longreach.		Rockhampton.		Winton.	
	Rise.	Set.	Rise.	Set.	Rise.	Set.	Rise.	Set.
1	14	23	30	39	5	14	34	44
6	27	13	43	28	18	3	50	31
11	29	10	45	24	20	0	52	27
16	19	19	35	34	10	10	39	39
21	12	28	27	43	1	19	29	52
26	11	28	26	43	0	19	28	51
31	21	15	38	31	12	6	43	35

MINUTES LATER THAN BRISBANE (NORTHERN DISTRICTS).

Day.	Cairns.		Cloncurry.		Hughenden.		Townsville.	
	Rise.	Set.	Rise.	Set.	Rise.	Set.	Rise.	Set.
1	19	37	42	56	27	41	17	32
3	31	31	51	51	35	35	25	26
5	43	18	59	43	44	27	36	17
7	52	7	64	35	50	21	43	8
9	56	2	68	32	52	17	46	3
11	53	4	67	33	50	19	44	5
13	43	12	60	38	45	24	36	12
15	34	22	53	45	38	30	28	19
17	24	32	46	53	31	38	21	28
19	19	41	42	58	27	44	17	35
21	9	50	37	63	21	49	8	42
23	3	56	34	67	18	53	4	46
25	3	53	34	66	18	51	4	44
27	11	44	38	60	23	46	10	37
29	23	32	46	53	30	38	20	28
31	34	20	54	44	38	29	29	18

Phases of the Moon.—First Quarter, 3rd July, 6.08 p.m.; Full Moon, 10th July, 5.41 p.m.; Last Quarter, 18th July, 4.01 p.m.; New Moon, 26th July, 5.33 a.m.

On 2nd July the Earth will be at its greatest distance from the Sun—94,600,000 miles. On the 15th it will rise and set approximately 25 degrees south of true east and true west respectively, and on the 16th and 30th the Moon will rise and set very close to true east and true west respectively.

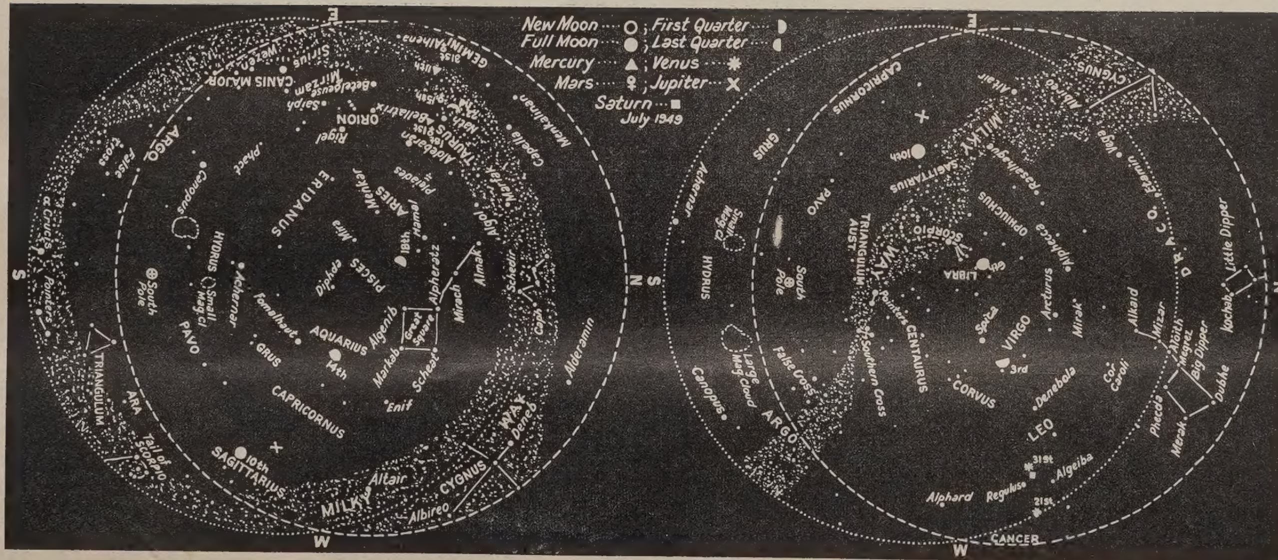
Mercury.—A morning object until the later part of the month. On the 1st, in the constellation of Taurus, it will rise 1 hour 40 minutes before the Sun and will be in line with the Sun on the 26th. By the end of the month it will set 20 minutes after sunset.

Venus.—In the constellation of Cancer, at the beginning of the month will set 1⅓ hours after the Sun. By the end of the month it will be in the constellation of Leo and on the 31st will pass less than 1 degree to the south of Saturn, when it will set 2 hours 8 minutes after the Sun.

Mars.—Now rising an hour or two before the Sun, it is observable in the east during morning twilight. On the 1st it will rise 1½ hours before the Sun and on the 31st, in the constellation of Gemini, will rise about 2 hours before the Sun.

Jupiter.—Now in the constellation of Sagittarius, will be favourably placed for observation during the month; on the 1st rising in the east 1 hour before the Sun sets in the west and on the 31st rising during the daylight hours.

Saturn.—In the constellation of Leo, now well to the west at sunset. On the 1st it will set between 10 p.m. and 11 p.m. and on the 31st between 7.15 p.m. and 8.30 p.m.



Star Charts.—The chart on the right is for 7.15 p.m. in the south-east corner of Queensland to 8.15 p.m. along the Northern Territory Border on the 15th July. (For every degree of Longitude we go west the time increases by 4 minutes.) The chart on the left is for 10 hours later. On each chart the dashed circle represents the horizon as viewed from Cape York and the dotted circle is the horizon for places along the New South Wales Border. When facing north hold "N" at the bottom; when facing south hold "S" at the bottom, and similarly for the other directions. Only the brightest stars are included and the more conspicuous constellations named. The stars, which do not change their relation to one another, moving east to west, arrive at any selected position about 4 minutes earlier each night. Thus, at the beginning of the month the stars will be in the positions shown about 1 hour later than the time stated for the 15th and at the end of the month about 1 hour earlier than that time. The positions of the Moon and planets, which are continually changing in relation to the stars, are shown for certain marked days. When no date is marked the position is for the middle of the month.